The Snohomish Salmon Overlay–A Tool for Regional Habitat Restoration Planning

Jon Houghton
Pentec Environmental

Paul Roberts
City of Everett

Abstract

The Snohomish Estuary Wetland Integration Plan (SEWIP) model was originally developed by an interagency expert panel under the lead of the Washington State Department of Ecology and the city of Everett. This model used the indicator value assessment approach to rate quality of tidal marine and estuarine areas for various natural resource functions including salmonid habitat (migration, feeding, saltwater acclimation, health, and predation). The SEWIP model also was used to rate habitat enhancement, restoration, and mitigation potential and to identify high-priority restoration projects in the study area. SEWIP was used to assess impacts and mitigation needs for a 7-acre nearshore fill in Everett Harbor and as an aid to design of a tidal restoration project.

In the Salmon Overlay, the original SEWIP model was revised by an expert panel of agency and tribal representatives to ensure that the model structure and output reflect the best available science related to how salmonids use tidal habitat. Tidal areas within the Snohomish Estuary and Port Gardner were scored using the Tidal Habitat Model (THM) to define the baseline or existing area and quality of habitat. Tidal areas and adjacent uplands were then rated for their restoration potential using the model. Actions required to achieve a 20% increase in habitat were identified and ranked. This goal was found to be achievable at reasonable cost.

Introduction

Background

The purpose of the Snohomish Estuary Wetland Integration Plan (SEWIP; City of Everett and others 1997) was to coordinate among agencies with jurisdictions over activities in or near water in the Snohomish River Estuary and to facilitate the cumbersome and complex regulations regarding these activities. With the SEWIP, an attempt was made to provide a better, more scientific basis for making regulatory decisions, and to make the regulatory process more efficient. The original SEWIP was developed by the interagency Snohomish Estuary Technical Advisory Committee (SETAC) and the Snohomish Estuary Users Committee working over a period of approximately 4 years (1993 to 1997).

Until 2001, the SEWIP had not been formally adopted by any jurisdiction. However, it was used as a reference tool to address a major Port of Everett development proposal (Pentec 1996a; 2000). The listing of chinook salmon (*Oncorhynchus tshawytscha*) and bull trout (*Salvelinus confluentus*) as “threatened” under the Endangered Species Act (ESA) had a sweeping effect on all local jurisdictions. In 1999, the city of Everett began work on the Salmon Overlay to update SEWIP to reflect these listings and to aid the city and region in planning restoration actions. Everett incorporated elements of SEWIP and the Salmon Overlay (City of Everett and Pentec 2001) into their Shoreline Master Program (SMP) revisions in March 2001.

Objectives of the Salmon Overlay

The Salmon Overlay was intended to aid the city and other jurisdictions in responding to ESA and developing an appropriate management plan for the estuary as a component of a basin-wide management strategy for recovery of listed species. Another intention of the SEWIP was to integrate the regulatory framework of federal, state, and local agencies into one process on the basis of an agreed-upon plan.

Specific objectives of the Salmon Overlay:

1. Develop a scientifically based Tidal Habitat Model (THM) to characterize indicators of salmonid habitat functions within the study area.
2. Conduct an inventory, based on the THM, of the quality of habitats now available to listed species in the study area.
3. Identify high-value habitats within the Urban Growth Area (UGA) that should be preserved.
4. Identify and rank projects and opportunities for restoration/enhancement of habitat within the planning area.

Two other objectives that are described in the Salmon Overlay are not covered in detail in this paper:

1. Recommend project impact assessment and mitigation policies, based on the THM.
2. Develop a process for comparing potential development impacts within the UGAs of Everett, Marysville, and Mukilteo (part) with potential mitigation and restoration opportunities in the SEWIP planning area.

The SEWIP planning area (Figure 1) (called the "area" or the "estuary" throughout this document) includes the marine shorelines and nearshore areas of Port Gardner and Possession Sound from Mukilteo to the southern entrance to Tulalip Bay and upriver to the point of divergence of Ebey Slough from the mainstem of the Snohomish River (approximately river mile 8). [Editor's note: Tables and figures appear at the end of this manuscript.]

Methods and Approach

Snohomish Salmon Overlay Technical Advisory Committee (SSOTAC)
The SSOTAC was formed to revise the original SEWIP Mudflat Model to reflect recent ESA listings of Puget Sound salmonids. The SSOTAC also reviewed the application of the THM to the tidal habitats in the planning area, participated in the revision of compensatory mitigation policies, and reviewed the Salmon Overlay restoration and management plan. SSOTAC members included wetland and fishery biologists from the city, Ecology, Washington State Department of Fish and Wildlife (Fish and Wildlife), Snohomish County, and the Tulalip Tribes. Their participation in this process does not imply an acceptance of the Salmon Overlay (City of Everett and Pentec 2001) by their respective organizations. However, the organizations reached consensus on major features of the THM and its use in restoration planning.

SEWIP THM
The THM is the result of the SSOTAC's substantial modifications to the anadromous fish portion of a model developed by the original SEWIP interagency technical advisory committee (City of Everett and others 1997). In a series of meetings extending over more than a year, the SSOTAC revised the model to reflect best available science and current knowledge of tidal estuarine and nearshore habitat requirements of listed and candidate salmonids.

Essential ecological functions provided to anadromous salmonids by habitats in the SEWIP area include feeding (rearing), migration, predator avoidance, and saltwater/freshwater adaptation. Of these, all are important to juvenile salmonids and juvenile and adult char; all but feeding are important to adult chinook salmon. Juvenile rearing during freshwater/saltwater transition and adult saltwater/freshwater osmoregulatory adjustment are two functions that are provided in the estuary that can occur nowhere else in the habitat continuum. These are considered to be obligate functions of the estuary; they are afforded particular emphasis in the model and in the ranking of restoration actions.

The model follows the indicator value assessment (IVA) method of the original SEWIP models and is patterned after the approach of Hruby and others (1995). As such, it describes the existing condition of habitat based on evident pathways, stressors, and indicators. As described by the National Marine Fisheries Service (NMFS 1996), pathways are groups of environmental factors that can potentially affect anadromous salmonids and their habitats. Stressors are non-natural (i.e., created or induced by human activities) constraints on the condition of habitat or its ability to provide ecological function. Indicators are metrics or descriptions of important environmental conditions that define the condition of each pathway or stressor. With a few exceptions, the model does not address habitat-forming processes but merely describes the existing expression of those processes.

Model development began with identification of important aspects (both positive and negative) of estuarine and nearshore habitat that affect the quality of habitat for performance of essential functions. The model scores discrete assessment units (AUs) of habitat, delineated by physical changes in habitat types or hydrological boundaries between units of habitat. The model asks a series of “yes” or “no” questions about the hydrological, chemical, physical, geomorphological, biological, and landscape features (indicators) present within the AU (Table 1).

The SSOTAC developed these questions and assigned relative values for a positive response to each using an expert system. Values (Table 1) were based on the degree to which each indicator was judged to be associated with the positive aspects of each function. Indicators strongly associated with the function were assigned a value of 3; those moderately associated were assigned a value of 2; those weakly associated with the function were assigned a value of 1. The raw score, in IVA units per acre, is simply the sum of all of the integers (1, 2, or 3) associated with a positive response to each question.

Aspects of some indicators were judged to be so disproportionately beneficial (e.g., large areas of native marsh) or adverse (e.g., stressors such as hydromodification or chemical contamination) that they were assigned positive or negative multipliers that are applied to the sum of the values from all the other indicators. Both the indicator value rankings of specific landscape features and the overall values of multipliers were assigned metrics based upon evidence from the literature where available, or where literature was lacking, by the collective best professional judgment of the SSOTAC.

To use the THM, the sum of all the integer scores (the raw score) is multiplied by any applicable positive multipliers to obtain the “intermediate score.” This score provides a measure of the potential habitat function that would be provided by the AU in the absence of any stressors. The intermediate score is then multiplied by the decimal fractions indicated in the model for any stressors present in the AU to obtain the final score, thus considered to be an indicator of habitat quality for salmonids. Rationales for the selection of indicators and the assignment of values to the AU when the indicators are present were developed along with protocols used for field scoring of AUs; both are provided in the Salmon Overlay (City of Everett and Pentec 2001). An example of the field inventory sheet is provided in Table 1.

The THM is thus a scientific (rather than a statistical) model that incorporates a suite of environmental attributes believed to be important to the functioning of salmonid habitat. Based on best professional judgment of the SSOTAC as an expert system, each model attribute (indicator) has been assigned a level of importance in determining salmonid habitat functions. “Validation” of a scientific model is accomplished by establishing its applicability and utility to the problem at hand (Mobrand Biometrics, Inc. 2000). In the case of the THM, the problem at hand is the description of relative function of tidal habitat for salmonids. Although statistical calibration of the THM is not possible, its legitimacy for its intended uses can be demonstrated by field measurements that confirm the relationships between model indicators and model scores. The standard for a scientific model is to establish that it meets its purpose better than alternative models that are available (Mobrand Biometrics, Inc. 2000).

The THM was “calibrated” in a non-statistical sense in a field exercise involving members of the SSOTAC. Ten AUs were visited and ranked using a draft THM and the output examined for consistency and legitimacy of the scientific logic and the resulting AU scores. Several changes were made to the model to better reflect the SSOTAC’s understanding of the implications of model scoring. The revised model (Table 1) was used for all work reported in this document.

Inventory and Description of Existing Conditions
Planning area AUs were first delineated on a series of 1998 aerial photographs obtained by Snohomish County from the Washington State Department of Natural Resources. Major categories of shoreline modification (e.g., bulkheads, riprap) were used in conjunction with major transitions in riparian condition or shoreline morphology in the initial delineation of AUs. This photo series was taken to the field and used as the base map and a primary data source for field assessment of each AU. Field surveys were completed in 4 days in late June and early July 2000. The scorings of AUs in this paper are considered to be at a reconnaissance level wherein best professional judgment was used to visually estimate the level of certain indicators (e.g., "Bulkheads are present along 10 to 50% of AU?" or "Bulkheads are present along less than 50% of AU?"). A more detailed application of the model would require additional work to actually measure the level or extent of certain indicators.

Final AU boundaries were transferred into the city's GIS system so that the area of each AU could be calculated. A set of conventions was developed for use in defining the specific AU boundaries in the waterward and landward directions (City of Everett and Pentec 2001).

The SEWIP THM scores for all AUs (IVA points) were multiplied by the acreage within each AU as determined by GIS. These products were then summed over each Ecological Management Unit (EMU) and over the entire estuary to define the baseline habitat condition in IVA-acres for listed salmonids (chinook and coho salmon and bull trout). The overall plan for management and restoration of the estuary was built from that baseline and considered as several separate elements.

Restoration Potential
The restoration potential of selected AUs and adjacent, currently nontidal areas within the estuary was assessed as follows:

- By evaluating the suite of potential restoration actions that could be taken in or adjacent to the AU (e.g., establish riparian vegetation, breach dikes, reduce slopes).
- By scoring the AU in its presumed restored condition.
- By comparing the number of IVA-acres in the existing and restored conditions.

Selected AUs both inside and outside the UGA were evaluated for their restoration potential through a variety of approaches (stressor removal, buffer enhancement, access improvement, and tidal restoration).

Ecological Management Units
This section briefly describes the seven EMUs based on their physical and biological resources. The estuary lies at the mouth of the Snohomish River, which is the second largest Puget Sound watershed (1,780 mi^2). Haas and Collins (2001) report that only about one-sixth of the historical marsh area remains in the estuary, as diking has isolated offchannel habitat and changed the channel edge environment of the mainstem Snohomish and its primary distributary sloughs.

The concept of EMUs is adapted from Pentec (1992) and the original SEWIP (City of Everett and others 1997) and combines existing land-use, hydrographic, and ecological factors in describing similar areas within the estuary. An historical retrospective analysis of major vegetation zones delimited by dominant hydrogeomorphic conditions (Haas and Collins 2001) has contributed to our understanding and delineation of these EMUs (Figure 2).

EMU 1 – Fluvial Fresh Water (Forested Riverine/Tidal)
EMU 1 generally includes tidal freshwater wetlands in the southern portion of the estuary (Figure 2). Salt-sensitive plant species in this area include skunk cabbage, yellow marsh marigold, and red-osier dogwood. Historically the area was a mosaic of tidal marshes, forested wetlands, and sloughs that were flooded daily. Today, however, the majority of wetlands within this EMU are diked and in agricultural production. Two notable exceptions are Otter Island, which was never diked, and South Spencer Island, which has been restored, in part, to tidal influence.

EMU 2 – Fluvial Brackish Water (Emergent/Forested Transitional)
EMU 2 generally includes the northern portion of the estuary immediately east and west of I-5 (Figure 2). The area comprises brackish tidal marshes and diked palustrine marshes. Salt-tolerant and moderately tolerant plant species are present. River and slough banks are moderately sloped and sandy, with rock riprap and pilings dominating banks along much of the Snohomish River mainstem. A narrow shoreline of sandy silts (mud) is present throughout most of the EMU. Extensive tidal marshes with dendritic channel systems, interspersed with islands of forested wetlands, dominated this EMU before diking. Historical industrial uses in this unit include the closed Weyerhaeuser mills and the Burlington Northern Railroad yard in the southwest portion of the EMU, as well as boat storage and wood chip facilities on Smith Island.

EMU 3 – River and Slough Mouths (Estuarine Emergent Marsh)
This EMU extends southwest along the Quilceda Creek tidal wetlands toward Priest Point, and south from the mouth of Quilceda Creek across saltmarsh and sandflats to the right bank of the Snohomish River west of SR 529 (Figure 2). Aquatic habitat consists of a combination of brackish wetlands, saltmarsh, and low-gradient mud- and sandflats. While considerable mixing of river and marine water occurs in this area, the saltwater influence results in the presence of marine species, such as barnacles, eelgrass, brown and green algae, and eastern softshell clam. Salt-tolerant plant species dominate the marsh vegetation.

Compared to EMUs 1 and 2, diking is limited in EMU 3 and confined to the west end of Smith Island. Undiked portions of the EMU resemble the natural historical condition of this part of the estuary. Log raft storage continues to be the major industrial use. However, recent declines in timber harvest have resulted in substantial reductions in log raft storage in this EMU.

EMU 4 – Delta Sandflats
EMU 4 encompasses the extensive sand- and mudflats of the inner and outer Snohomish River delta, and those west of Jetty Island (Figure 2). Because the area is subject to the waves and currents of Puget Sound and salinities exceeding 30 parts per thousand, it is predominantly marine in character. Small brackish marshes and saltmarshes are found on Jetty Island, and extensive eelgrass beds are present west of the island. The creation of Jetty Island from dredged material has been the major impact on this unit. Before the creation of Jetty Island, this area consisted of intertidal and subtidal sand- and mudflats with meandering channels, but it lacked shoreline and island habitat. The shorelines and shallow-water areas surrounding Jetty Island are highly productive, supporting many species of fish and invertebrates (Pentec 1996b).

EMU 5 – Lower Snohomish Channel
EMU 5 contains highly modified or artificially created habitats in the Snohomish River channel and the industrialized area of the Everett waterfront between Preston Point southward to Naval Station Everett (Figure 2). Before the construction of Jetty Island, this EMU resembled the extensive mud- and sandflats that persist today in EMUs 3 and 4. Other emergent marshes similar to Maulsby Swamp likely were present along the base of the bluff south toward the naval base. Farther south, the littoral area was probably composed of mixed sands, silt, and mud. The mainstem Snohomish River probably meandered out over the delta, but certainly was shallower and wider than its present dredged configuration.

Much of shoreline along this portion of the Everett waterfront has been modified by hard structures, including rock riprap, pilings, concrete bulkheads, docks and adjacent roads, parking lots, and industrial yards and buildings. This area has been extensively dredged and filled since the inception of the City of Everett. Extensive mudflats persist waterward of Maulsby Swamp and along the east side of Jetty Island, but they have been extensively used for log raft storage.

EMU 6 – Everett Harbor (East Waterway)
The East Waterway was transformed into a deepwater marine port by dredging and filling in the early part of the last century, and has provided shipping and processing facilities for timber, pulp, and alumina. As a result, this EMU consists primarily of highly modified deep water and some limited shallow subtidal and intertidal habitat. Littoral habitats are associated largely with fill, as nearly all mudflat areas have been eliminated by dredging, filling, riprap, or bulkheads. Before industrialization, EMU 6 was probably

composed of beaches consisting of cobbles and mixed sands and silts similar to those that currently line the Mukilteo shoreline to the south.

EMU 7N, 7S – Port Gardner Nearshore, Tulalip Nearshore
This EMU includes intertidal beach habitat and subtidal areas to -30 ft MLLW. Mid- and upper-intertidal areas are typically composed of cobble and gravel; lower intertidal and subtidal areas are predominantly mixed sands and silts. The EMU stretches from the entrance to Tulalip Bay south to Priest Point (EMU 7N, Figure 2), and from the mouth of Pigeon Creek (south Everett) west to Mukilteo (EMU 7S, Figure 2). This EMU is primarily marine but is influenced by fresh water from the Snohomish River as well as small local streams. The upper beach in EMU 7S is highly modified by railroad lines. The Tulalip shoreline is less affected by single-family residential development and associated losses to riparian habitats from bulkheading, as substantial reaches of feeder bluffs remain (e.g., in the Mission Beach area).

Results and Discussion

Overall Ranking of Assessment Units
In June and July 2000, 132 AUs within the seven EMUs (Figure 2) were delineated and scored using the THM. Final AU scores ranged from 2 to 147.4 (all AU scores are in IVA units per acre). All AU scores were normalized to 100, and the final AU score range was 1.4 to 100 (Figure 3). Raw scores, intermediate positive multiplier scores, stressor values, final AU scores, IVA-acres, final normalized scores, and limiting species (chinook or coho salmon and bull trout) are provided in the Salmon Overlay (City of Everett and Pentec 2001).

The frequency distribution of normalized scores was plotted to identify logical groupings of scores, and by extension, habitat quality classifications. From the normalized score distribution, we determined that appropriate habitat classification breaks existed at scores of 16 (less than 16 equals low habitat quality) and 42 (16 to 42 equals medium habitat quality; greater than 42 equals high habitat quality; Figure 4). All of the 35 highest-ranking AUs (the top 27%) had high raw score values and multipliers exceeding 1.9. Minimal stressors (negative multiplier 0.63 or higher; i.e., low stress) were present at only 10 of the 35 AUs. The largest concentration of these high-quality habitats lies along the eastern distributary channels (Figure 4).

Medium quality AUs, scoring between 16 and 42 IVA points, typically (36 of 41 AUs) had intermediate to high raw scores and positive multipliers (up to 3.0). However, stressors (Table 1) were present in 15 of the 41 AUs. These AUs are considered to provide medium-quality habitat functions for listed salmonids and may (with the removal of stressors) have a good potential for restoration.

AUs scoring below 16 IVA points characteristically had low to intermediate raw scores, one or no positive multipliers, and one or more stressor (negative) multipliers. Because stressor multipliers outweighed positive multipliers, most final AU scores in this group were less than their AU raw score. Nearly half of the 132 AUs evaluated were deemed to provide low-quality habitat functions for listed species (Figure 4).

IVA scores were strongly influenced by the number of positive multiplier habitat indicators observed in each AU. Positive multipliers (Table 1) included presence of a deep tidal channel, extensive marsh or eelgrass, feeder bluffs, and large woody debris (LWD) recruitment source. The highest-ranking AU (Otter Island, AU 1.33) had three positive multipliers. IVA scores also were strongly influenced by presence of stressors. The number of stressors scored in an AU ranged from none to seven. Over 60% of the AUs contained at least one stressor, and cumulative stressor multiplier values ranged from 0.90 (low stress) to 0.11 (high stress). The two most frequently scored stressors both related to presence of riprap and vertical bulkheads (Table 1).

Salmonid Habitat Area and IVA-Acre Scores in the Snohomish River Estuary and UGA
The entire SEWIP planning area (Figure 2) encompasses 20,262 acres, of which 42.4% (8,595 acres) comprises currently accessible salmonid habitat area (Table 2). This total includes both inwater habitat and riparian buffer habitat (up to 187 ft wide in some cases), and includes all of Otter Island. The functional quality score of each AU (IVA points per acre) was multiplied by the acreage within the AU to provide the

estimate of function-area for each AU. These function-area values were then summed to provide the estuary-wide total of 506,609 IVA-acres. Table 2 shows the AU-acres and IVA-acres for the various geographic subareas within the estuary (e.g., EMUs, UGA).

It is noteworthy that EMU 1, which has the largest total area of any EMU, also has the smallest percentage of its total area (9.5%) that is salmonid habitat. The highest percentage of total area that is tidal is found in EMUs 4 and 7, which consist primarily of open-water and shoreline areas at the mouth of the estuary (Figure 4). It is also noteworthy that AU 4.05, the broad expanse of the Snohomish delta west of Jetty Island, contains 38.5% of the salmon habitat acreage in the entire planning area. Because of the presence of uniform sandy mudflats from about MLLW to -6 ft MLLW, and because of the extent of eelgrass coverage, this AU had the second highest score in the marine EMUs (4 and 7). The combination of large area and high functional quality result in this single AU providing nearly 47% of all the existing salmon function-area (IVA-acres) in the planning area.

Ranking of AUs in the UGAs of Everett, Mukilteo, and Marysville

Sixty-eight AUs are located within the Everett UGA. For the purpose of ranking AUs in the nearshore environment of the UGA, we included two AUs that are partially (AU 7.10) or wholly (AU 7.11) contained within the city of Mukilteo UGA. Contained within the combined UGA are 3,909 acres and 203,600 IVA-acres of salmonid habitat (Table 2). Note that where AUs lie across the UGA boundary, only that portion within the boundary is included in these totals. The 18 AUs with the highest habitat quality (4th quartile of normalized IVA scores) are shown on Figure 5. Fourteen of these 18 AUs contained at least one positive habitat multiplier indicator (tidal channel, marsh area, LWD recruitment, eelgrass area). Other AUs, classified as having poor-, low-, and medium-quality habitats (1st, 2nd, 3rd quartile scores) are also shown. Most AUs within the combined UGA have experienced significant development to date. As a result, only 10 AUs (14%) contain no stressor indicators.

Thirteen AUs, all contained within EMU 2, are located within the city of Marysville UGA (Figure 5). These AUs were ranked separately from those within the Everett/Mukilteo UGA.

Hypothetical Development Scenario (HDS)

The HDS was used to evaluate whether sufficient area and restoration/enhancement opportunities would be available in the estuary to provide compensatory mitigation for impacts on salmonid habitat under what is considered to be a realistic, maximum-development scenario.

Areas where shoreline and floodplain development may occur within the SEWIP planning area were defined initially to include all AUs contained within the combined Everett and Mukilteo UGA (Figure 5) and an area outside the City of Everett UGA at Marshlands (AU 1.19). This potential development area, comprising 68 AUs, was then modified by excluding from potential development those AUs scoring in the top quartile of all AUs within the combined UGA. Additionally, AUs bordering Jetty Island (AUs 4.03, 5.07, and 5.12) were excluded, as was the Maulsby Marsh (AU 5.00), because they have existing land uses, land-use designations, or logistical constraints that preclude development. This resulted in exclusion from the HDS of 21 AUs representing about 76% of the salmon habitat area and about 93% of the salmon habitat function within the UGA (Table 2). In total, these areas excluded from the HDS have been identified as having medium- to high-quality salmonid habitat (Figure 4) and are excluded from intensive development in the City of Everett’s SMP (2000).

The remaining AUs considered in deriving the HDS included 46 AUs, containing 939 acres and 13,384 IVA-acres of salmonid functional habitat (Table 2). These AUs include about 11% of the total tidal habitat area (acres) in the SEWIP planning area but only about 2.6% of the salmon functional habitat (IVA-acres; Table 2). The HDS was developed from within only a portion of these AU (Figure 6; Table 3).

Potential Development Impacts from the Hypothetical Development Scenario

The HDS assumes that land uses causing impacts to salmonid habitat are allowed, consistent with the city’s SMP (City of Everett 2000) and the compensatory mitigation policies provided in the Salmon Overlay (City of Everett and Pentec 2001). To conservatively determine potential impacts on shoreline and palustrine wetlands that would result from the HDS, we assumed worst-case scenarios for the potential future development of those AUs within each shoreline land-use designation (Table 3). Some of the AUs do not appear likely to undergo development, despite their location within the UGA; for example, no development was assumed in AUs between the Pigeon Creek No. 1 delta (AU 7.04) and the Mukilteo tank farm (AU 7.10). Worst-case future development impacts on other shoreline areas are expected to arise from dredging and filling of nearshore or mudflat areas, hardening of littoral habitats, loss of marsh area below OHW, and loss of riparian areas (Table 3). In other cases, sites within AUs are in the development planning or permitting process pending regulatory approval, and impacts can be calculated based on actual plans. Generally, impacts from development were assumed to reduce AU IVA scores, and several also reduce total AU area (Figure 6). Impacts assumed to result from full development of lands under the HDS may include the following:

Tidal Habitat Impacts. We used the THM to evaluate potential tidal habitat impacts at locations in 10 AUs and estimated potential full buildout at these locations, based on assumptions of the types of development that could occur (Table 3). These impacts would reduce littoral area (shown in yellow on Figure 6) by approximately 226 acres and also would reduce IVA scores within individual AUs (Table 3). (Note that approximately half of this loss of littoral area would result where dredging increased depths to greater than -10 ft MLLW, and thus would not be a loss of aquatic habitat or Waters of the State.) The expected functional area loss would be 4,942 IVA-acres. These impact assumptions are consistent with the types of development allowed within each shoreline land-use designation (City of Everett 2000).

Isolated Palustrine Wetland Impacts. The HDS also considers potential development in nontidal areas within the Snohomish flood plain. Isolated palustrine wetlands within diked areas may be filled or altered by development under the HDS (gray-shaded areas on Figure 6). Alternatively, palustrine wetlands may be converted by tidal inundation where mitigation/restoration occurs to benefit anadromous salmonids. Because the goals and objectives of estuarine restoration are to increase tidal habitat for anadromous salmonids, the policy preference of the Salmon Overlay is to mitigate the loss of palustrine wetlands with tidal habitat, especially where tidal inundation occurred historically. Thus, we assumed acre-for-acre tidal habitat replacement of palustrine wetlands lost to development, and an average ratio of 0.3 acre of tidal habitat provided for each acre of palustrine wetland converted to tidal habitat for mitigation (Salmon Overlay Policy P.16; City of Everett and Pentec 2001).

To estimate the potential nontidal palustrine wetland acreage lost, we identified those Wetland Complex Areas (WCAs) (from the original SEWIP, City of Everett and others 1997) affected under the HDS. We excluded those WCAs that were immediately adjacent to tidally influenced areas (Figure 6), since these areas were included as Salmon Overlay AUs and were already evaluated with the THM. To conservatively estimate the palustrine wetland acreage contained within each WCA, we used the higher percentage of either seasonal or permanent open water observed within the WCA as scored in the SEWIP (City of Everett and others 1997) Vegetated Complex IVA model.

Next, we screened each WCA with the city of Everett (2000) SMP Land-Use Designations to estimate the level of impact and the loss of wetland acreage. We assumed 100% of all wetlands in Urban Mixed-Use Industrial shoreline areas would be filled or lost due to full long-term buildout. In the Marshlands area, we assumed 50% of all wetlands would be lost to floodplain development. In the WCA surrounding the Simpson Lee property, we assumed 25% of palustrine wetlands would be lost or altered through redevelopment of roads, trails, railroad modifications, and construction activities. In Urban Maritime shoreline areas we assumed 100% of palustrine wetland areas would be lost. This excludes losses of mudflat area and habitat function, which were evaluated using the THM (Table 3). In Municipal/Water Quality shoreline areas we assumed 100% of all wetlands would be lost to City of Everett Water-Pollution Control Facility maintenance, future expansion, trail expansion, and future overbuilt dike construction.

Based on these assumptions, total estimated loss (from development activities only) of isolated palustrine wetlands in the city of Everett UGA would be 306 acres. These areas have no direct present function as habitat for salmonids; however, this loss of acreage would need to be mitigated, preferably through tidal restoration, on an acre-for-acre basis, per the compensatory mitigation policies of the Salmon Overlay.

Loss of Restoration Opportunity. The loss of restoration opportunity represents the foreclosure of potential future restoration where impacts will occur if AUs considered under the HDS are developed. To calculate these impacts, the THM was used to score habitat indicators that could be realistically restored within the AU in the absence of development including log raft storage restrictions, buffer enhancement, access improvements, and tidal restoration. Note that some of these restoration options would not necessarily be foreclosed and might be stimulated by some forms of redevelopment in the HDS. The potential increase in function (IVA points per acre) that would be gained by each of these restoration actions is shown on Figures 7 and 8 and tabulated in Tables 4 through 6. These scores represent potential increases in function that would be lost, in part, under the HDS, but do not reflect habitat gains that would be required under the mitigation policies of the Salmon Overlay.

Potential Compensatory Mitigation/Restoration Opportunities in the Snohomish River Estuary

General. Snohomish Estuary mitigation/restoration opportunities fall under three main headings: stressor removal, riparian buffer enhancement, and tidal restoration. Only tidal restoration projects (compensatory mitigation or restoration) will contribute to the mitigation of lost acreage or can increase net salmon habitat acreage within the estuary. Riparian buffer enhancement and stressor removal can potentially improve habitat functions and therefore increase IVA-acre points or credits within individual AUs.

Stressor Removal. Stressors in the THM, such as log rafting, riprap, and vertical bulkheads, fractionally reduce present habitat quality in many AUs. Stressors that reflect hardened infrastructure (vertical bulkheads, overwater structures) may be difficult or too expensive to physically remove or alter because of adjacent land uses. Other stressors, like log rafting or restricted fish access to existing habitats are more easily removed and may therefore represent the most likely means of increasing habitat function in some AUs (Figure 7). The removal of stressors may not increase available habitat area for salmonids, but habitat quality and IVA scores can be increased nonetheless. In other words, stressor removal represents potential habitat enhancement in the form of IVA-acres, but not necessarily as net habitat area.

Log rafting impacts could be removed from up to 22 AUs in the estuary (Figure 7; Table 5). The removal of these stressors represents a substantial increase in AU IVA scores that might be achieved in a minimum of time, and with no adverse effects (i.e., loss of palustrine wetlands, construction impacts, unanticipated impacts). However, alternative means of transporting and storing logs would need to be developed and implemented by the log-handling industry. Development of these means would likely require construction of new shallow-draft (barge) berths elsewhere in the UGA. In AUs where log-transfer facilities now operate, removal of these facilities was assumed to accompany cessation of log storage.

In addition to the removal of log rafting, the removal of the access barrier to Maulsby Marsh would potentially increase the IVA-acre point value of this AU by 2,546 points. The removal of these stressors from 12 AUs inside the UGA would represent an increase of 8,822 IVA-acre points (Table 5). The removal of log raft storage from 11 AUs outside the UGA would provide an increase of 34,990 IVA-acres (Table 5). No new or restored acreage would be gained through removal of these stressors.

Riparian Vegetation Enhancement. Riparian vegetation enhancement may occur in certain shoreline areas (Urban Industrial, Urban Multi-Use) designated for redevelopment. In these areas, unless water-dependent commercial activities are proposed, 50- to 100-ft vegetated buffers, mostly in areas largely devoid of riparian vegetation, must be restored with redevelopment. This long-term enhancement could potentially increase the IVA score in many AUs that did not have all the possible riparian function indicators scored in the model.

The primary impediments to enhanced riparian buffers are conflicting shoreline land uses and the requirement to maintain the integrity of functioning dikes. Riverfront redevelopment will provide the opportunity to create riparian buffers, especially along the mainstem of the Snohomish River. Enhanced 50- to 100-ft buffers could run along the left bank of the Snohomish River from SR 529 south to Simpson Lee. Additionally, riparian buffer enhancement could occur (up to 200-ft buffers) on the north-facing side of Smith Island if setback levees were constructed. Over the long term, these riparian buffer enhancements represent potential increases of 1,246 IVA-acre points in these AUs (Table 6). Actual area of tidal habitat as defined in the Salmon Overlay would be increased by 22 acres. This type of enhancement would comprise less than 6% of all enhancement opportunities and would require a long time to achieve the predicted IVA-acre gains.

Tidal Restoration. Many potential tidal mitigation/restoration opportunities exist within the Snohomish River Estuary, both inside and outside the UGA (Figure 8). These opportunities include the reconnection of historic tidal channels, the removal of dikes and levees, and the removal or reconfiguration of tide gates to create tidal mudflat or vegetated marsh areas. Areas behind dikes arguably have little or no present value to juvenile or adult salmon using the estuary, except where a habitat process such as the recruitment of LWD still occurs. The THM structure dictates in all cases that these areas behind dikes score zero IVA points. With the restoration of tidal influence over a site, the habitat can immediately be scored with the model, although full realization of the habitat functions assumed by the model may take a year or more. The IVA scores we calculated for individual projects conservatively represent habitat restoration potential and IVA-acre credits that could be expected to be built into the project (e.g., tidal channels) or to develop within 5 years following construction (e.g., riparian marsh vegetation). Substantial additional benefits could be expected to accrue over the longer term through additional marsh development, improvements to riparian areas, and development of LWD recruitment potential.

Twenty-five potential tidal restoration sites were identified in the SEWIP study area (Figure 8; Table 4). Many of these sites have been previously recognized in the SEWIP plan (City of Everett and others 1997) and by Haas (2001) for their restoration potential. Additional sites were identified as a result of the Salmon Overlay analysis and based on the personal knowledge of SSOTAC members. These sites do not represent the entire suite of sites where tidal restoration could occur in the estuary. Because it is unlikely that funding or the political will to implement tidal restoration at all 25 of these sites will be available in the near future, sites were ranked for their restoration potential using a simple mathematical model, based on the following factors:

- Potentially achievable salmonid habitat function scores (calculated by the THM).
- Existing wildlife functions on the site (calculated by 1997 SEWIP freshwater wetlands model).
- Existing water quality functions on the site (calculated by 1997 SEWIP freshwater wetlands model).
- Potential technical difficulties associated with project construction (e.g., presence of roads or utilities).
- The position of the site in the estuarine landscape; higher scores were given to sites in EMU 2 and 3 and additional credit was given to sites on the mainstem of the Snohomish River.

The ranking model is described in the Salmon Overlay (City of Everett and Pentec 2001). Results of application of the ranking model (Table 6, left column) should not be construed to mean that the top-ranked sites must be constructed before moving down the list. All projects on the list would provide significant habitat benefits. Factors not included in the model, such as existing land uses, owner willingness to sell, and cost, will have a major influence on project feasibility and the sequence of project completion.

We scored each tidal restoration site under a scenario that projects a reasonable maximum potential IVA score (Table 4). This scenario projects the condition of a site based on active reconfiguration and management over a prolonged period (10+ years). It assumes that a sinuous or dendritic tidal channel would be constructed before dike breaching, that fish access is not restricted, that elevations would be modified so that riparian marsh would develop rapidly, and, in some cases, that the riparian zone would be enhanced or that LWD recruitment could be provided. Sites restored in this fashion would score in the moderate to high range among existing tidal AUs (Table 4).

Inside the UGA we considered 10 potential restoration sites, which contain approximately 1,215 acres of historically tidally influenced or flooded areas (Table 4). The total habitat restoration potential is estimated to be 1,145.9 acres and 80,952 IVA-acres based on predicted restoration-site habitat conditions.

Outside the UGA we considered 15 potential restoration sites, which could restore tidal hydrology to approximately 4,245 acres, providing up to 332,656 IVA-acres if all projects were constructed as restoration rather than as compensatory mitigation (Table 4). This maximum (optimally engineered and managed) scenario, including tidal restoration both inside and outside the UGA, over the long term would result in an increase of 63% in the total salmonid habitat acreage in the estuary and an increase of 82% in the total IVA-acres in the estuary.

Compensatory Mitigation Balance

In this section, we evaluate the potential net effect on tidal salmonid habitat of the maximum buildout of the HDS for the Everett/Mukilteo UGA, assuming implementation of concomitant compensatory mitigation requirements as defined in this section. The THM was first used to calculate the development "debits," based on the IVA-acre losses, of existing anadromous fish habitat that would result from full buildout of the HDS (Table 3; Figure 6). As summarized in Table 7, full buildout would result in the loss of about 226 acres of littoral habitat to deepening or filling and a loss of about 306 acres of isolated palustrine wetlands to filling or draining, for a total of 532 acres of loss equating to 4,942 IVA-acres of salmon habitat functional area.

Those debits were then compared to the "credits" that would be gained from required mitigation for those losses based on the compensatory mitigation policies in the Salmon Overlay to arrive at a predicted net increase in IVA-acres that would result from the HDS. We assumed that on average, mitigation sites, which are largely outside of the UGA, would have fewer stressors and a higher number of IVA points per acre than would impacted sites within the UGA. Hence, the minimum acreage policy (1-for-1 replacement of lost littoral acreage) would dictate the acreage of mitigation required.

We assumed that the project proponent would elect to compensate for both littoral habitat and palustrine wetland losses through tidal restoration. Salmon Overlay Policy P.16 (Loss of Palustrine Wetlands) then will govern the amount of tidal restoration that will be required to offset the expected losses of palustrine wetlands on mitigation sites. To assess the habitat area and quality that would be provided by mitigation of the full buildout scenario, we made the following assumptions and calculations:

- A minimum of 532 acres of new tidal habitat would be required to compensate for the loss of 532 acres of littoral and palustrine wetlands affected by the HDS (Table 7).
- Mitigation would be provided in EMU 2 and/or 3 in advance of impacts, through restoration of tidal hydrology in areas that are now diked; e.g., along lower Union Slough or Steamboat Slough.
- Two hundred acres of the selected mitigation sites are delineated as existing palustrine wetlands (70% [140 acres] low quality, 20% [40 acres] fair quality, and 10% [20 acres] moderate quality) that must be compensated for using the ratios in Salmon Overlay Policy P.16. Compensation required will thus be (0.1 X 140) + (0.3 X 40) + (0.5 X 20) = 36 acres.
- A minimum of 532 + 36 = 568 acres will thus be required to compensate for the littoral habitat lost (226 acres) and the palustrine wetlands lost to development (306 acres) or converted to tidal habitat at the mitigation sites (36 acres).
- At the time of the impact, restored tidal wetlands in formerly diked mitigation areas provide an average of 40 IVA points per acre (e.g., Marysville sewage treatment plant mitigation site; AU 2.12 = 56 IVA points for chinook, 48.5 IVA points for coho/bull trout; Salmon Overlay, Appendix Table E.1).
- Thus, the total mitigation provided would be 568 acres X 40 IVA points per acre, or 22,720 IVA-acres (Table 7). This is an increase of 17,759 IVA-acres and a functional replacement ratio of 4.6.
- Under this scenario, the assumed loss of 226 acres of littoral habitat would have been compensated for by restoration of tidal functions to 568 acres, for a net area increase of 342 acres of new salmonid habitat and a replacement ratio of 2.5 acres for each acre lost.

If the mitigation required is viewed in the context of the entire planning area, this mitigation would result in a 4% increase in salmon habitat area and a 3.5% increase in salmon habitat function. If the AU (4.05) encompassing the Snohomish delta, in which no impacts or restoration will ever occur, is excluded from the calculation of "existing habitat," the mitigation scenario described in Table 7 would constitute an increase in both salmon habitat area and function of 6.5 percent.

This exercise demonstrates that, with the use of the proposed SEWIP mitigation policies, full buildout under the HDS would result in a significant net increase in salmonid habitat area and quality.

Management and Restoration Plan

Overall Salmonid Habitat Management Goals for the Estuary

The ultimate goals of estuary management for recovery of listed salmonids are to preserve remaining natural ecosystem components and processes that provide for salmonid habitat productivity and, to the extent necessary for recovery, to restore and enhance those processes that have been lost or degraded. The Salmon Overlay (City of Everett and Pentec 2001) recognizes the critical location and function of the Snohomish River Estuary for the health and sustainability of all salmonid stocks in the Snohomish River system. Preserving existing high-quality habitats and increasing the area and quality of other habitats in the estuary will maximize the chances that native salmonid populations can achieve the abundance, geographic distribution, and life-history diversity to be self-sustaining and productive into the future.

Salmonid habitat restoration within this plan emphasizes modification of existing and potential habitat areas within the estuary toward conditions extant in the pristine estuary (e.g., Haas and Collins 2001). These modifications also will affect habitats for other resources that will be modified to become more similar to precontact conditions. These changes will come at the expense of certain land uses (e.g., agricultural lands), habitats (e.g., palustrine wetlands), and resources (e.g., waterfowl, terrestrial wildlife) that now are present in the modified estuary. Emphasis on tidal habitat restoration over large areas of the estuary will displace existing land uses, including palustrine habitats for freshwater wetland plants and wildlife.

This plan also recognizes that ecosystem protection, enhancement, and restoration must be balanced with the need for future economic development and redevelopment within appropriate sites in the UGAs of municipalities in the planning area. The THM was used above to evaluate those potential future development impacts and the availability of compensatory mitigation opportunities. Assuming the full development as described in the HDS, and assuming mitigation in accordance with the compensatory mitigation policies of the Salmon Overlay, development and associated mitigation would result in small net increases in overall salmonid habitat area (about 4.0 percent) and function (about 3.5 percent) in the planning area. Although these increases would be substantial and important, development and associated mitigation alone cannot be relied upon to effect salmon habitat recovery.

This section provides a recommended management and restoration component of the estuary management plan. The goals and objectives of salmon habitat restoration in the planning area are identified along with a prioritization of restoration opportunities and approaches that could be used to achieve those goals.

The SSOTAC has adopted the following overall management goals for the planning area (including Port Gardner):

Management Goal 1: Protect existing high-quality, undeveloped salmon habitat areas within the estuary, and preserve options for future restoration opportunities.

Management Goal 2: Enhance and restore the Snohomish River Estuary and the processes that create and maintain estuarine habitat for salmonids and other species to the maximum extent compatible with the GMA, SMP, and the Snohomish River basin chinook salmon recovery work plan (WRIA 7 Technical Committee 1999).

Management Goal 3: Achieve a net gain in salmonid habitat area, functions, and values for salmonids in the estuary that is reflective of and will support Snohomish basin salmonid recovery goals.

Management Goal 4: Achieve a balance between habitat protection, enhancement, and restoration, and continued economic and social activity within appropriate areas.

Management Goal 5: Provide an efficient permit review process that promotes consistency among applicable federal and state laws and regulations, including the federal Section 404 review process and ESA. The permit review process also should provide development and environmental interests with a high degree of certainty as to the level of development permitted and the location, type, amount, benefits, and costs of required mitigation.

Management Goal 6: Compile detailed information for adaptive resource management and protection, as follows:

1. Map all palustrine wetland complexes and tidal AUs and assess their functions using the original wetland (City of Everett and others 1997), and the revised THM (Figures 3 and 4).
2. Review and summarize available biological, physical, and chemical data for the estuary (City of Everett and Pentec 2001).
3. Monitor mitigation and restoration actions to provide information to guide future actions within the context of the Salmon Overlay. Use monitoring data collected over time to test assumptions made in the THM.

Management Goal 7: Provide a level of certainty of implementation of the restoration plan that is acceptable to NMFS and the US Fish and Wildlife Service. Certainty has come through adoption of the SEWIP Salmon Overlay as a component of the city of Everett's revised SMP and potentially, by acceptance of the Overlay by other entities.

Habitat Recovery, Restoration, and Enhancement Objectives
The following specific habitat recovery, restoration and enhancement objectives are proposed, consistent with the goals of the Snohomish River basin chinook salmon recovery work plan (WRIA 7 Technical Committee 1999):

1. Protect existing high-quality salmonid habitat and migration corridors within the estuary and within the UGA.
2. Minimize further losses of and improve access to historically accessible habitats *inside* of the UGA, including tidal areas and streams tributary to the estuary; ensure that existing tidal marshes and littoral areas remain hydrologically and functionally linked to main channels or marine areas.
3. Prevent further losses of and improve access to historically accessible habitats *outside* of the UGA, including tidal areas and streams tributary to the estuary; ensure that existing tidal mudflats, marshes and littoral areas remain hydrologically and functionally linked to main channels or marine areas.
4. Restore tidal circulation and habitat structure by breaching dikes to reconnect intact but isolated formerly tidal habitats; breach dikes to create mudflat-marsh-channel complexes in areas historically providing such habitats.
5. Protect intact riparian zones and enhance and restore disturbed riparian zones adjacent to estuarine and nearshore areas; protect and restore historic floodplain wetlands; provide for large wood and associated organic matter to enter the channel through natural processes.
6. Protect functioning feeder bluffs and restore feeder bluff functions, where possible.
7. Protect existing sources of LWD and restore LWD sources where possible.
8. Reduce or eliminate stressors to salmonids and to salmonid habitat functions through systematic actions (regulatory compliance, contaminant removal, elimination of intertidal log raft storage, reductions in shoreline armoring).
9. Over the next 15 years, increase salmonid habitat function, as defined by the THM, by 20% overall. This increase is considered an intermediate-term goal, not the ultimate goal of tidal habitat restoration in the planning area. Clearly much more could be accomplished (e.g., Table 4 and Figure 8) and would be desirable if the funding and landowner cooperation can be obtained.

Overall Restoration/Enhancement Potential
Over the last century, the Snohomish River Estuary has lost approximately 70% of the tidal mudflat, marsh, and forested wetland habitat that was historically present (Bortleson and others 1980). Because much of this area was simply diked for agricultural use, the soils and topography behind the dikes are largely intact over large areas. Other reductions in habitat function have resulted from man-caused stressors such as log raft storage and sediment contamination, which can be reversed. Because of the nature of the losses in habitat area and function that have resulted from urban, industrial, and agricultural development over the

last century, the Snohomish River Estuary has a substantial potential for restoration of salmonid habitat function.

The potential increase in habitat (IVA-acres) that would result from a suite of potential restoration actions inside and outside the UGA is shown in Tables 4 through 6). These are by no means the only restoration opportunities in the planning area. For example, riparian buffer enhancement could be accomplished in many AUs not listed on Table 6, and opportunities for tidal habitat restoration occur in areas not shown on Figure 8. However, it must be reiterated that not all of these potential restoration actions necessarily are feasible, practical, socially acceptable, or economically available. They are presented merely to demonstrate what is possible; further real-estate and economic analysis would be necessary to refine a practical strategy for habitat restoration in the estuary.

The 25 potential tidal restoration sites shown on Figure 8, if all were constructed and managed to maximize salmonid habitat functions, would increase the existing tidal habitat area in the estuary by nearly 5,400 acres, or 63 percent. Similarly, this scenario would result in an increase of about 66% in the total salmonid function (IVA-acres) in the estuary. If the exceptionally large Snohomish delta AU (AU 4.05), which is unlikely to be directly impacted or significantly enhanced by human activities, is eliminated from the definition of "existing conditions," then the completion of these 25 projects would increase existing salmon habitat acreage in the remaining planning area by over 100 percent.

The rankings of the 25 potential restoration projects are reflected in the numbers assigned to each in Table 4 and Figure 8. The model provides a higher ranking for restoration sites of a larger size; larger ecological units tend to facilitate critical habitat processes and biological interactions, which in turn improve the ability of a restoration site to be sustainable over the long term. Sites near the top of the ranking generally had a combination of high salmon-habitat-restoration potential (IVA-acres; associated with large size), moderate to low existing values for wildlife and water quality functions, and low technical difficulty. The importance of existing functions in determining site ranking can be seen by contrasting Site 1, North Tip, South Ebey Island, with Site 25, South Ebey, Fish and Wildlife. These sites were ranked 1 and 2, respectively, based solely on salmon restoration potential; however, because the South Ebey Fish and Wildlife site ranked last for having both the highest existing wildlife and the highest existing water quality scores, it ended up last in the overall ranking.

Preliminary Estuarine Recovery Plan

Development of a habitat recovery plan for the Snohomish River Estuary and associated nearshore areas within the SEWIP planning area must include input from salmon-habitat and population biologists from state and federal resource agencies, as well as from a variety of other stakeholders. The plan proposed in this section reflects consideration only of those aspects of habitat dealt with in the SEWIP THM and only the obvious existing land-use constraints. For example, tidal restoration carries with it a certainty that existing agricultural, commercial, transportation, and residential activities will be displaced. Certain formerly tidal areas that have been filled and are being actively used for economic activity are not considered as offering significant restoration potential.

As noted above, the proposed interim habitat-recovery goal is to increase the salmon habitat function in the SEWIP planning area, as measured by the THM, by 20% in 15 years. In Table 8, we list a specific suite of mitigation/restoration actions that would achieve that goal. Some of these actions involve properties already wholly or partially in public or tribal ownership and already intended as mitigation or restoration sites (e.g., Biringer Farms, Diking District 6); other actions listed would require property acquisition. No attempt has been made to evaluate the costs of these actions. From examination of Table 8, it can be seen that the mitigation and restoration actions are spread among EMUs 1 through 5, with the majority of the actions in EMUs 1 and 2, where historical analysis has shown high rates of past loss of tidal habitats (e.g., Table 2). Only minimal restoration potential has been identified in EMUs 6 and 7 (Figures 7 and 8), and none is assumed in this scenario.

This plan provides a suite of mitigation actions that would compensate for the full buildout scenario under the HDS and would result in an overall increase of 15% in salmon habitat area and 20% in salmon habitat function as measured by the THM. This is a realistic and achievable goal. Yet, substantially greater restoration opportunities exist in the planning area, and greater habitat benefits could be gained if the will and the funding exist.

Summary

As noted in this report and in the original SEWIP (City of Everett and others 1997), one purpose of the original SEWIP was to coordinate the sometimes cumbersome and complex regulatory framework governing development in or near water. The SEWIP provided a scientifically based management plan within the context of which various federal, state, and local agencies could base their respective regulatory decisions. The original work was to be used as the basis for an agreed-upon approach to management in the estuary. Sensitive resources were to be identified and a plan adopted by governments with appropriate jurisdiction to protect and provide opportunities to restore these resources.

With the listing of chinook salmon and bull trout as "threatened" under the ESA, the focus of SEWIP has shifted to providing a response for protection and restoration of habitat for these two species within the estuarine and nearshore environment of the lower Snohomish River and WRIA 7—the Snohomish basin. While NMFS recovery efforts are focused on the so-called 4H strategy (habitat, harvest, hydrology, and hatcheries), local governments are responsible only for habitat where they have jurisdiction, and therefore have some potential liability for their actions. The revised SEWIP with the Salmon Overlay provides a scientific basis for salmon habitat protection and restoration activities in the study area.

The SEWIP Salmon Overlay (City of Everett and Pentec 2001) is a tool to aid jurisdictions in responding to the specific needs presented by the ESA. The original plan provides significant baseline information on the estuary for a number of wetland and environmental characteristics. The Salmon Overlay provides additional information specific to the needs of chinook salmon and bull trout in the plan area. The Overlay includes:

1. A scientifically based THM that uses indicators of habitat structure that have been shown to affect salmon habitat functions within the study area to characterize habitat quality for listed species.
2. An inventory, based on the THM, of the quality of habitats now available to listed species in the study area and identification of high-value habitats that should be preserved within the UGA.
3. A process for comparing potential development impacts within the UGAs of Everett, Marysville, and Mukilteo (part) with potential mitigation and restoration opportunities in the SEWIP study area; recommended mitigation and restoration/enhancement policies for development.
4. A listing and ranking of opportunities for restoration/enhancement of habitat within the planning area.
5. A restoration scenario that accommodates mitigation for the HDS and substantial increases in tidal habitat area and function for anadromous salmonids.

The SEWIP, as revised with this Salmon Overlay, has a number of applications for governments, technical and scientific interests studying fish resources and habitat, and property owners in or near the study area. These applications are outlined here as recommendations for consideration by policy makers, decision makers, advisors, technical experts, resource managers, and property owners.

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Table 1 Tidal Habitat Model – indicator field questionnaire.

SEWIP IVA for Estuarine or Marine Habitat					
(This model assumes source of water is tidal fresh, brackish, or marine)					
Date	**Surveyors On Site or Off Site? Circle**				
AU #	**Supplement w/Aerials? Date and Type**	**Y/N**	**CH**[1]	**CO/BT**[1]	**Functions Addressed**[2]
Hydrology					F, M, O
1	AU has vernal or perennial freshw ater stream or spring		3	3	F, O
2a	AU is depositional (slow currents, low w ave action) over 25% of littoral area		2	2	F
2b	AU is depositional (slow currents, low w ave action) over 50% of littoral area		3	3	F
3	AU has refuge from high velocities (e.g., during max. ebb)		3	3	M, P
4a	AU contains a natural tidal channel w etted at MLLW		X1.5	X1.3	F, P
4b	AU contains tidal channel w etted at MSL (i.e., shallow drainage)		2	2	F, P
5	Tidal channel is dendritic or highly sinuous		3	3	F, P
Water Quality					
6a	Fresh w ater only (salinity <0.5 ppt)		1	3	F
6b	Oligohaline to Mesohaline (sal. variable: often 0.5-5 ppt, can range to 18 ppt)		3	3	F, O
6c	Polyhaline (sal. typically 18-30 ppt)		1	1	F, O
7a	Temp/DO meet criteria for salmonid health during major use periods		2	2	H
7b	Temp/DO meet criteria for salmonid health at all times		3	3	H
Physical Features					
	Vascular plant/mud (or sand) flat boundary (vegetated/unvegetated boundary)				
	Shoreline complexity				
8a	Ratio of length of MHHW boundary to w idth at MLLW >3 (include islands)		3	3	F, P
8b	Ratio of length of MHHW boundary to w idth at MLLW 1.2-3 (include islands)		2	2	F, P
8c	Ratio of length of MHHW boundary to w idth at MLLW <1.2 (include islands)		1	1	F, P
Exposure					
9	AU is sheltered from w aves		2	2	F
Slope					
10a	Slope of substrate in littoral zone >10h:1v (i.e., low gradient)		3	3	F, P
10b	Slope of substrate in littoral zone <10h:1v but >5h:1v (i.e., moderate)		2	2	F, P
10c	Slope of substrate in littoral zone <5h:1v but >2h:1v (i.e., steeper)		1	1	F, P
Range of Depths					
11a	>10% of AU is littoral (MHHW to -10 ft; use OHW if marsh veg. above MHHW)		1	1	F, P
11b	>25% of AU is littoral (MHHW to -10 ft; use OHW w here veg. indicates)		2	2	F, P
11c	>50% of AU is littoral (MHHW to -10 ft; use OHW w here veg. indicates)		3	3	F, P
Sediments (surficial only)					
12	Substrate in littoral zone - silty sand >25% of area		1	1	F
13	Substrate in littoral zone - mud or mixed fine 25-50% of area		2	2	F
14	Substrate in littoral zone - mud or mixed fine >50% of area		3	3	F
15	Upper intertidal zone contains potential forage fish spaw ning habitat		3	3	F
Vegetated Edge					
	Below OHW				
16a	Buffer: marsh edge >10 ft w ide over 50% of shoreline		3	3	F, P
16b	Marsh edge >5 ft w ide over 50% shoreline; or >10 ft w ide over 25-50% of shoreli		2	2	F, P
16c	Marsh edge exists but <5 ft w ide, or less than 25% (but >5%) of shoreline		1	1	F, P
16d	Marsh of native species occupies over 25% of total AU		X 2	X 2	F
	Above OHW (riparian zone)				
17a	Riparian scrub-shrub and/or forested >25 ft w ide over 10-24% of shoreline		1	1	F, P
17b	Riparian scrub-shrub and/or forested >25 ft w ide over 25-50% of shoreline		2	2	F, P
17c	Riparian scrub-shrub and/or forested >25 ft over 50% of shoreline		3	3	F, P
18	Riparian vegetation is dominated by native species		1	1	F
19	Riparian zone provides significant source of LWD recruitment		X1.5	X1.5	F, P

(continued)

1 BT-bull trout, CH-chinook, CO-coho

2 F-feeding, H-healthy/toxicity, M-migration, O-osmoregulatory, P-predator avoidance

Table 1 (continued).

AU #	Supplement w/Aerials? Date and Type	Y/N	CH[1]	CO/BT[1]	Functions Addressed[2]
Landscape					
20a	AU has low - to mod-gradient intertidal continuity w/adjacent AU (one side)		1	1	M, P
20b	AU has low - to mod-gradient intertidal continuity w/adjacent AUs (both sides)		3	3	M, P
Special Habitat Features					
	LWD Density (LWD must be in the IT zone below MHHW)				
21a	1.0 piece/channel width, /30 m of shoreline, or /100 m² of AU whichever greater		3	3	P
21b	0.5 piece/channel width, /30 m of shoreline, or /100 m² of AU whichever greater		2	2	P
21c	0.2 piece/channel width, /30 m of shoreline, or /100 m² of AU whichever greater		1	1	P
Submerged Vegetation (note provisions with regard to impacts to macrovegetation)					
22	Algal cover over 10% of littoral area (during springtime)		1	1	F, P
23a	Eelgrass or kelp (laminarians) is present along 5-10% of low tide line of AU		1	1	F, P
23b	Eelgrass or kelp (laminarians) is present along 10-25% of low tide line of AU		2	2	F, P
23c	Eelgrass or kelp (laminarians) is present along over 25% of low tide line of AU		3	3	F, P
23d	Eelgrass or kelp (laminarians) occupies over 25% of total area of AU		X 2	X 2	F, P
24	Do functioning feeder bluffs provide a sig. source of sediment to the AU?		X 2	X 2	F
Stressors					
25a	Immigration/emigration restricted 25-50% of the time		X 0.8	X 0.8	M
25b	Immigration/emigration restricted 50-75% of the time		X 0.5	X 0.5	M
25c	Immigration/emigration restricted 75-90% of the time		X 0.3	X 0.3	M
26a	Wood debris present on the bottom 25-75% cover over AU		X 0.7	X 0.7	F
26b	Wood debris present on the bottom >75% over AU		X 0.5	X 0.5	F
27a	Log rafting affects 10-50% of AU on a recurring basis		X 0.7	X 0.7	F
27b	Log rafting affects over 50% of AU on a recurring basis		X 0.5	X 0.5	F
28a	Water col. conditions exceed salmonid thresholds during periods of high abund.		X 0.3	X 0.3	H
28b	Water col. conditions exceed salmonid thresholds during periods of low abund.		X 0.7	X 0.7	H
29a	Sediment chemical contam. present (>SQS over more than 25% of AU)		X 0.8	X 0.8	F, H
29b	Sediment chemical contam. present (>CSL over more than 25% of AU)		X 0.6	X 0.6	F, H
30a	Riprap or vertical bulkheads extend below MHHW for 10-50% of shore		X 0.8	X 0.9	P,M,F
30b	Riprap or vertical bulkheads extend below MHHW along >50% of shore		X 0.7	X 0.8	P,M,F
31	Maj. of riprapped or bulkheaded shoreline extends below MSL (+6 ft MLLW)		X 0.8	X 0.9	P,M,F
32a	Finger pier or dock >8 ft wide		X 0.9	–	P
32b	Two or more finger piers or docks >8 ft wide; or single pier/dock >25 ft wide		X 0.8	X 0.9	P
33a	Overwater structures cover 10-30% of littoral area in AU		X 0.8	X 0.9	P,M,F
33b	Overwater structures cover 30-50% of littoral area in AU		X 0.7	X 0.8	P,M,F
33c	Overwater structures cover 50-75% of littoral area in AU		X 0.5	X 0.7	P,M,F
33d	Overwater structures cover >75% of littoral area in AU		X 0.4	X 0.5	P,M,F
34	Littoral benthic hab. routinely disturbed by prop wash, chronic oil spills, dredging		X 0.9	X 0.9	H, F

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Table 2. Total salmon habitat area and functions in acres and IVA-acre points for SEWIP geographic, political, and ecological areas.

	Area (acres)				Functional Area (IVA-acres)	
Geographic/ Political Area	**Total (tidal & uplands)**	**Tidal Habitat**	**Tidal Habitat as % of Total Area**	**% of Total Tidal Habitat Area**	**IVA-acres**	**% of Total Habitat Function**
EMU 1	8,117.0	772.3	9.5	9.0	57,846	11.4
EMU 2	4,336.0	1208.4	27.9	14.1	84,474	16.7
EMU 3	835.1	631.3	75.6	7.3	40,029	7.9
EMU 4	4,337.6	4245.1	97.9	49.4	251,347	49.6
EMU 5	1,161.4	606.3	52.2	7.1	9,061	1.8
EMU 6	417.8	74.4	17.8	0.9	214	0.0
EMU 7	1,057.4	1057.4	100.0	12.3	63,639	12.6
SEWIP Planning Area Total	20,262.3	8595.2	42.4	100.0	506,609	100.0
Everett UGA[1]		3909.0	19.3	45.5	203,600	40.2
Marysville UGA		217.0	1.1	2.5	16,307	3.2
AUs Considered in the HDS[2]		938.8	4.6	10.9	13,384	2.6

1 For AUs containing habitat both within the UGA and outside the UGA, only the area within the UGA boundary is included.

2 Includes AUs in Everett and Mukilteo UGAs.

Table 3 Potential development impact assumptions and calculations by AU (loss of tidal habitat and resulting mitigation IVA-acre debits).

	Existing Conditions				Post-Development Conditions				
AU	AU IVA Score	AU Acres	IVA Acres	Impact Acre Loss	AU Acres	IVA Score	IVA Acres	Mitigation Debit, IVA-Acres	Impact Assumptions
5.08	19.4	226.5	4,392.6	150.0	74.6	19.3	1,440.2	2,952.4	Fill and/or dredge 150 acres; 50% low slope shore; marsh fringe
2.28	64.0	19.9	1,273.0	7.0	12.9	18.8	242.0	1,031.0	Dredging for water dep. uses; dock <24 ft wide, loss of riparian
7.10	13.0	31.8	413.4	16.6	15.3	5.0	76.3	337.2	Dredging for marina, loss of shoreline area to riprap/bulkheads
5.04	11.2	37.6	420.8	21.1	16.5	9.5	156.9	263.8	Approximately 80% fill; 24-ft pier; mod. slope; marsh fringe
5.05	17.4	9.4	163.9	7.6	1.9	17.5	32.9	131.0	Approximately 80% fill; mod. slope; marsh fringe
5.10	6.7	14.6	96.9	11.9	2.7	5.9	15.8	81.2	Dredge all mudflat; construct marina, retain fringe habitats
7.04	13.4	34.3	460.6	6.0	28.3	13.4	380.5	80.1	Assume 4-acre fill, maintain shoreline conditions as is
5.01	10.0	16.9	168.8	1.2	15.7	8.2	128.8	40.0	Partial fill of remaining nonbulkhead area
6.04	4.2	13.1	54.5	2.0	11.0	3.5	38.6	15.9	Assume fill of Foss, slip even w/existing modified shoreline
6.06	2.0	7.2	14.7	2.4	4.8	1.2	5.8	8.9	Fill across new marginal wharf, reduce littoral area <30 ft MLLW
Total		411.2	7,459.2	225.7	183.7		2,517.7	4,941.5	

Table 4 Potential tidal/restoration sites and estimates of IVA-acre credits achievable.

		Acreage				Restoration Potential	
Site[1]	**Restoration Site**	**Potential New**	**Setback Levee**	**Converted Wetlands**	**Potential IVA Score**	**Acres[2]**	**IVA-acres**
Inside UGA							
7	Marshlands 1	368.7	14.3	29.0	85.2	354.4	30,196
9	Ferry Baker Island	5.6	- -	- -	127.5	5.6	714
11	Simpson Lee Cat. I #311	35.0	- -	- -	73.8	35.0	2,583
12	Smith Island Delta Front	154.0	10.9	4.6	77.6	143.1	11,105
14	Marshlands 2	502.3	26.0	35.2	59.6	476.3	28,385
18	Langus Park #50	26.3	- -	- -	63.7	26.3	1,675
21	N. Smith Is., Union Slough	16.9	4.2	0.5	75.5	12.7	1,065
22	SR 529 Spencer	6.8	2.9	0.4	77.6	3.9	434
23	Smith Slough, Smith Island	17.0	10.3	3.3	79.7	6.7	534
24	Upper Union Slough	82.0	0.0	11.5	52.0	82.0	4,262
	Subtotal	1,214.6	68.7	84.4		1,145.9	80,952
Outside UGA							
1	North Tip, S. Ebey Island	423.1	5.0	20.9	103.7	418.0	44,764
2	Biringer Farm	347.3	7.6	13.6	85.0	339.8	29,600
3	Mid-Smith Island	499.1	15.1	37.7	75.5	484.0	36,985
4	S. Spencer Island WDFW	297.1	0.0	14.7	124.2	297.1	36,899
5	Poortinga Property	378.0	23.5	19.6	67.2	354.5	24,194
6	S. Ebey Island, SW Tip	44.3	- -	- -	32.8	44.3	1,453
10	Deadwater Slough	655.4	34.4	32.6	58.0	620.9	36,015
8	Swan Slough	61.6	- -	- -	78.8	61.6	4,851
15	Sunnyside South	341.4	20.2	43.0	85.0	321.2	27,903
13	Sunnyside North	196.5	14.3	13.3	81.6	182.3	15,020
16	Nyman Farm	50.0	0.0	4.2	127.3	50.0	7,483
17	S. Ebey Island, NW Corner	146.9	- -	- -	40.3	146.9	5,913
19	S. Ebey Island, NE Corner	182.2	- -	- -	70.4	182.2	12,816
20	Diking District 6	231.9	6.7	45.3	70.0	225.2	15,958
25	S. Ebey Island WDFW	532.0	15.1	39.9	62.1	516.8	32,801
	Subtotal	4,386.8	142.0	284.6		4,244.8	332,656
Totals		5,601		369		5,391	413,608

1 Site number corresponds with Figure 8. Numbers indicate ranking per ranking model.
2 Balance in acreage is calculated from GIS areal values less estimated setback levee footprint.
- - indicates site was not included in mitigation use scenario.

Table 5 Assessment units with high potential for stressor removal and IVA-acre enhancement.[1]

	Current IVA Score	Acres	IVA-acres	Restoration Action	Restoration IVA Score[2]	IVA-acre Enhancement	% IVA-acre Enhancement
AUs Considered Inside HDS							
5.00	28.3	34.1	965.3	improve access	94.3	2,252.2	233.3
5.08	19.4	226.5	4,392.6	log raft removal	38.8	4,394.4	100.0
5.03	13.3	38.5	513.0	log raft removal	29.6	626.9	122.2
5.04	11.2	37.6	420.8	log raft removal	22.4	420.8	100.0
5.02	13.2	23.9	315.9	log raft removal	26.4	315.9	100.0
2.40	9.9	32.7	322.9	log raft removal	14.1	138.3	42.8
6.02	2.7	47.7	129.2	log raft removal	5.4	129.3	100.0
5.10	6.7	14.6	96.9	log raft removal	13.3	96.8	99.9
2.43	10.2	20.8	212.2	log raft removal	14.6	90.9	42.9
6.04	4.2	13.1	54.5	log raft removal	8.3	53.9	98.9
6.06	2.0	7.2	14.7	log raft removal	2.9	6.3	42.7
6.03	2.1	2.7	5.6	log raft removal	3.0	2.4	42.7
Subtotal		499.3	7,443.6			8,528.3	114.6
AUs Considered Outside HDS							
3.04	71.5	274.1	19,603.8	log raft removal	102.0	8,352.3	42.6
2.02	62.7	144.5	9,066.5	log raft removal	99.6	5,324.8	58.7
3.05	51.7	151.9	7,848.7	log raft removal	82.0	4,609.6	58.7
3.01	39.3	87.6	3,441.8	log raft removal	87.4	4,210.1	122.3
3.03	66.0	79.8	5,265.1	log raft removal	105.0	3,109.7	59.1
4.02	15.4	378.9	5,835.4	log raft removal	22.0	2,500.9	42.9
4.01	17.5	328.3	5,745.6	log raft removal	25.0	2,462.4	42.9
3.02	101.9	38.0	3,869.3	log raft removal	146.0	1,677.3	43.3
2.04	57.4	63.4	3,638.0	log raft removal	82.0	1,559.1	42.9
2.05	45.4	33.8	1,532.3	log raft removal	72.0	899.9	58.7
5.07[3]	12.5	52.7	661.3	log raft removal	17.9	283.4	42.9
Subtotal		1,633.0	66,507.7			34,989.5	52.6
Total		2,132.3	73,951.4			43,517.8	58.8

1 AUs are ordered by potential IVA-acre enhancement.

2 Where log transfer facilites are present, enhanced score includes cessation of both log transfer and storage.

3 Note that AU 5.07 is inside the UGA but not considered part of the HDS.

Table 6 Hypothetical development scenario potential riparian buffer enhancement and IVA-acre point credits.[1]

AU	Current IVA Score	Acres	IVA-acres	Enhanced IVA Score	Enhanced Acres[1]	IVA-acre Enhancement	%IVA-acre Enhancement
1.08	4.5	4.8	21.7	7.2	1.7	12.1	55.7
1.09	9.1	2.1	19.4	10.6	0.7	7.5	38.8
1.10	7.1	2.1	14.8	7.8	0.7	5.6	37.6
1.12	6.7	6.8	45.8	11.2	1.7	19.4	42.3
1.13	30.2	13.6	411.6	47.3	0.0	116.1	28.2
1.15	29.0	5.5	160.1	45.8	0.0	46.4	29.0
2.28	64.0	19.9	1,273.0	94.4	5.0	475.8	37.4
2.40	9.9	32.7	322.9	39.2	1.3	51.5	16.0
2.41	49.0	7.4	362.3	49.0	1.0	49.5	13.7
2.43	10.2	20.8	212.2	14.6	1.7	24.5	11.5
2.44	51.2	8.0	409.1	59.2	1.1	63.3	15.5
2.47	19.2	4.0	77.2	21.8	1.3	27.6	35.7
2.51	14.4	15.3	219.9	37.1	1.4	52.5	23.9
2.54	6.6	3.7	24.0	10.1	1.2	11.7	48.9
3.05	51.7	151.9	7,848.7	88.0	3.2	282.5	3.6
Totals			11,422.6		22.0	1,245.9	10.9

1 Under the protocols used to define the upland boundary of each AU (Section 2.4), all areas would be increased by inclusion of a 25-ft-wide strip above ordinary high water where new riparian vegetation is provided.

Table 7 Mitigation balance for full development scenario in the UGA - Mitigation Scenario 1 (all mitigation through tidal restoration).

	Acres		IVA-acres	
	Credit	Debit	Credit	Debit
Existing Conditions - Salmon Habitat				
Snohomish Estuary SEWIP area (from Table 4.2)	8,595		506,609	
SEWIP area less AU 4.05	5,288		271,827	
AU in area considered for development (HDS, from Table 4.2)	939		13,384	
Hypothetical Development Scenario Impacts				
HDS impacts (from Table 4.3)		226		4,942
HDS palustrine wetland impacts (acres) (from Table E.3)		306		
Totals		532		4,942
Mitigation Requirements				
Minimum 1:1 (Policy P.3)		532		
Assume 200: acres palustrine wetlands on mitigation site				
Acres low quality at 0.1:1 (Policy P.16)	140	14		
Acres fair quality at 0.3:1	40	12		
Acres moderate quality at 0.5:1	20	10		
Total tidal acres required		568		
Assumed IVA-acres provided (Assumed nominal 40 IVA points per acre)			22,700	
Net increase in salmon habitat from development and mitigation	**342**	**acres**	**17,759**	**IVA-acres**
Percent increase in estuarywide salmon habitat from development and mitigation	4.0%		3.5%	
Percent increase in estuarywide salmon habitat from development and mitigation (excluding AU 4.05)	6.5%		6.5%	
Mitgation ratio provided by development scenario	**2.5**		**4.6**	

Table 8 Proposed restoration scenario (assuming full development under the HDS).

		Area (acres)		Function (IVA-acres)	
Line		Credit	Debit	Credit	Debit
Existing conditions - salmon habitat					
1	Snohomish Estuary SEWIP planning area (from Table 2)	8,595		506,609	
	a. Planning area less AU 4.05, Snohomish delta platform	5,288		267,154	
2	Restoration goal in 15 years (20% of line 1)			101,322	
Development impact scenario (from Table 7) [1, 2]					
3	Total impact (palustrine and tidal acres; tidal functions)		532		4,942
4	Mitigation requirements based on requirements of policies P.3, P.17		568		6,424
5	Mitigation actions (assumes median IVA points per acre in Table 4)				
	a. Restore tidal circulation to Maulsby Marsh (AU 5.00; Table 5)	–		2,252	
	b. Restrict log raft storage in AU 5.07 (northeast Jetty Is.; Table 5)	–		283	
	c. Debit remaining acres in Port of Everett's Union Slough Mitigation site	8		440	
	d. Restore tidal circulation to 200 acres at the Marshlands 1 (Site 6)	200		11,740	
	e. Restore tidal circulation at Biringer Farm (Site 2)	340		19,895	
	f. Debit remaining acreage at Upper Union Slough (Site 24)	20		802	
6	Total mitigation for full buildout under HDS	568		35,413	
7	Net gain in habitat acres from this impact/mitigation scenario (line 6 - line 4)	342		30,472	
8	Remaining restoration goal to reach 20% increase in planning area function (line 2 - line 7)			70,850	
Restoration actions (in approximate order of preference/probability)					
9	Restore tidal circulation: Poortinga Farm Site 5 (mitigation for Tulalip landfill)	354		16,355	
10	Restrict log raft storage in AU 2.40, 3.01, 4.01, 4.02 (Figure 7; Table	–		9,312	
11	Restore tidal circulation to Diking District 6 (Site 20)	225		11,599	
12	Restore tidal circulation to north end of South Spencer Is. (Site 4)	297		30,289	
13	Restore tidal circulation to 100 acres of Deadwater Slough (Site 8)	100		4,390	
14	**Net gain under this plan (sum line 7 plus 9 through 13)**	**1,318**		**102,416**	
15	**Percent change from existing condition (line 14 / line 1)**	**15%**		**20%**	
16	**Percent change from existing condition (less AU 4.05; line 14 / line 1a)**	**25%**		**38%**	

1 Policy numbers refer to the Salmon Overlay (City of Everett and Pentec, 2001).
2 Site numbers refer to Table 4 and Figure 8.

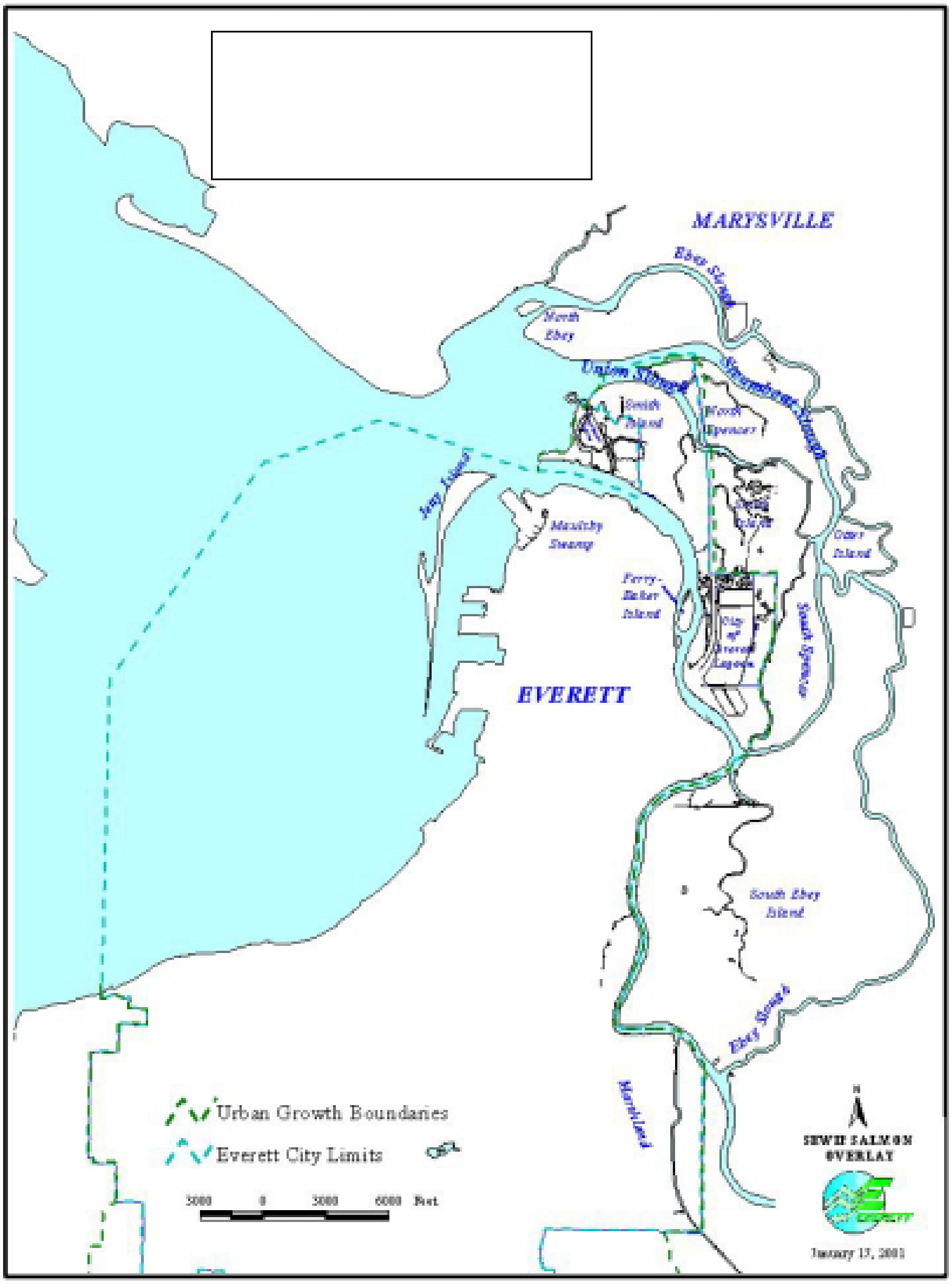

Figure 1. Snohomish River Estuary and nearshore planning area.

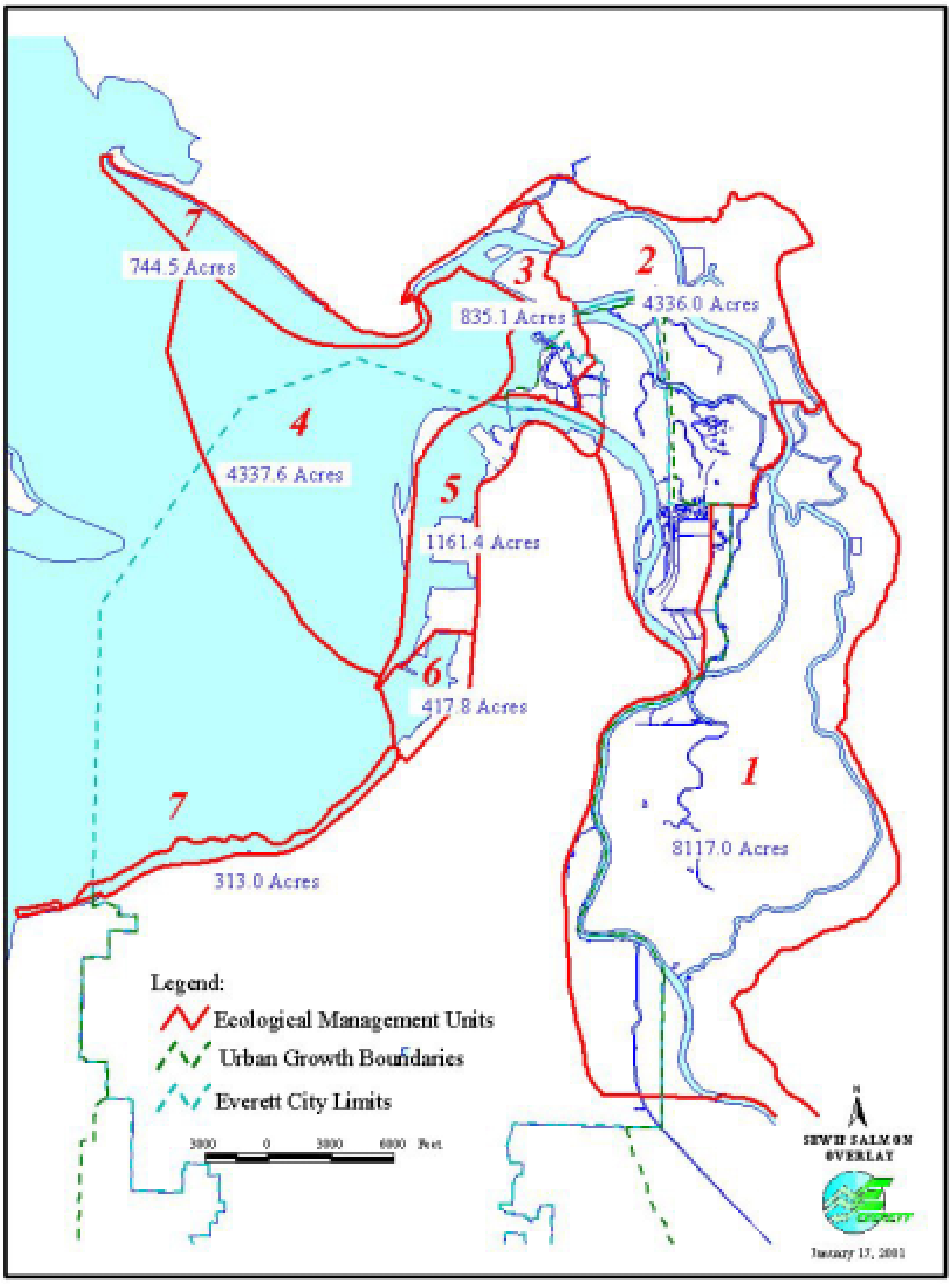

Figure 2. Ecological Management Units and total EMU area.

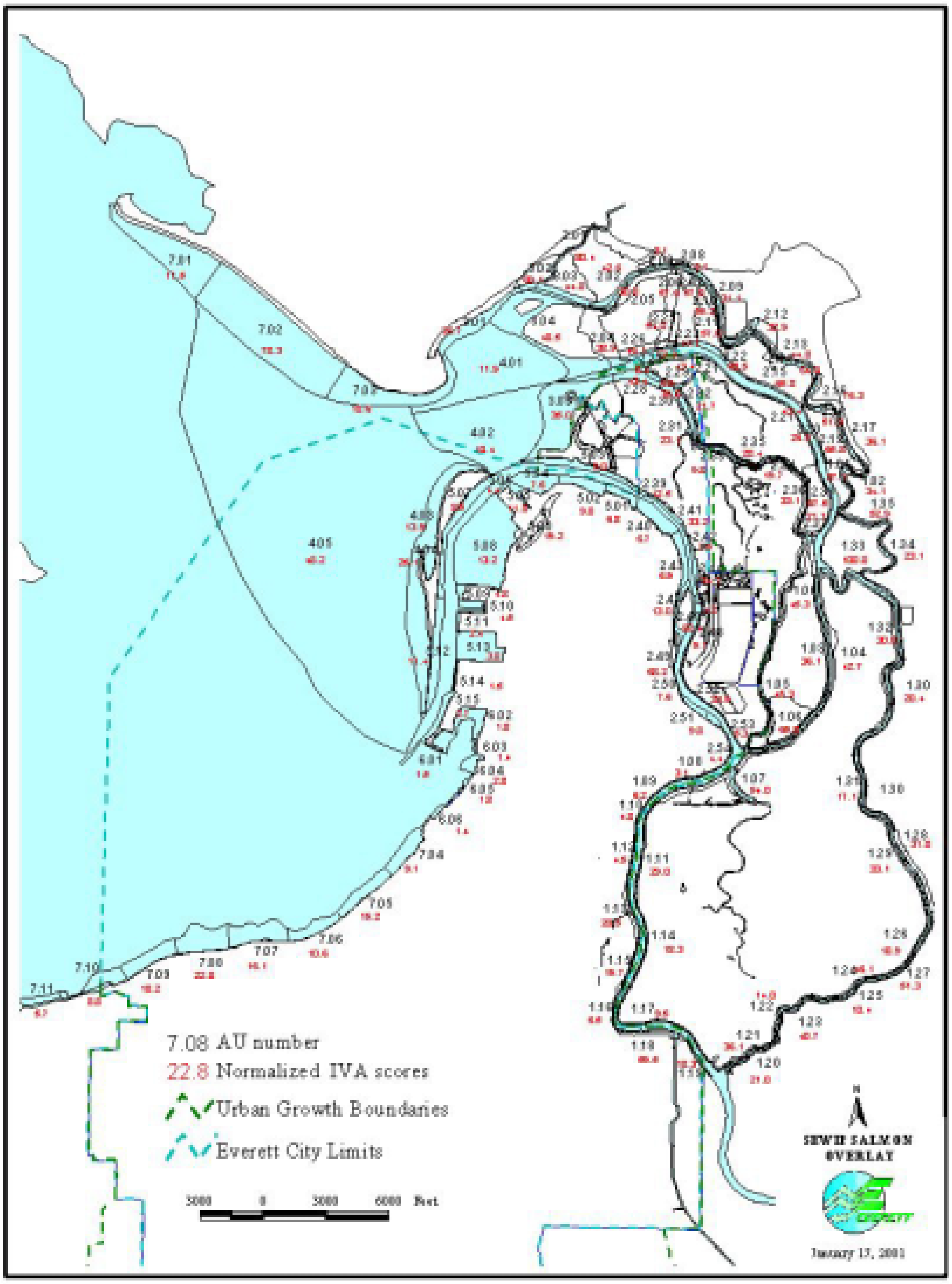

Figure 3. Assessment Units (n=132) and normalized score.

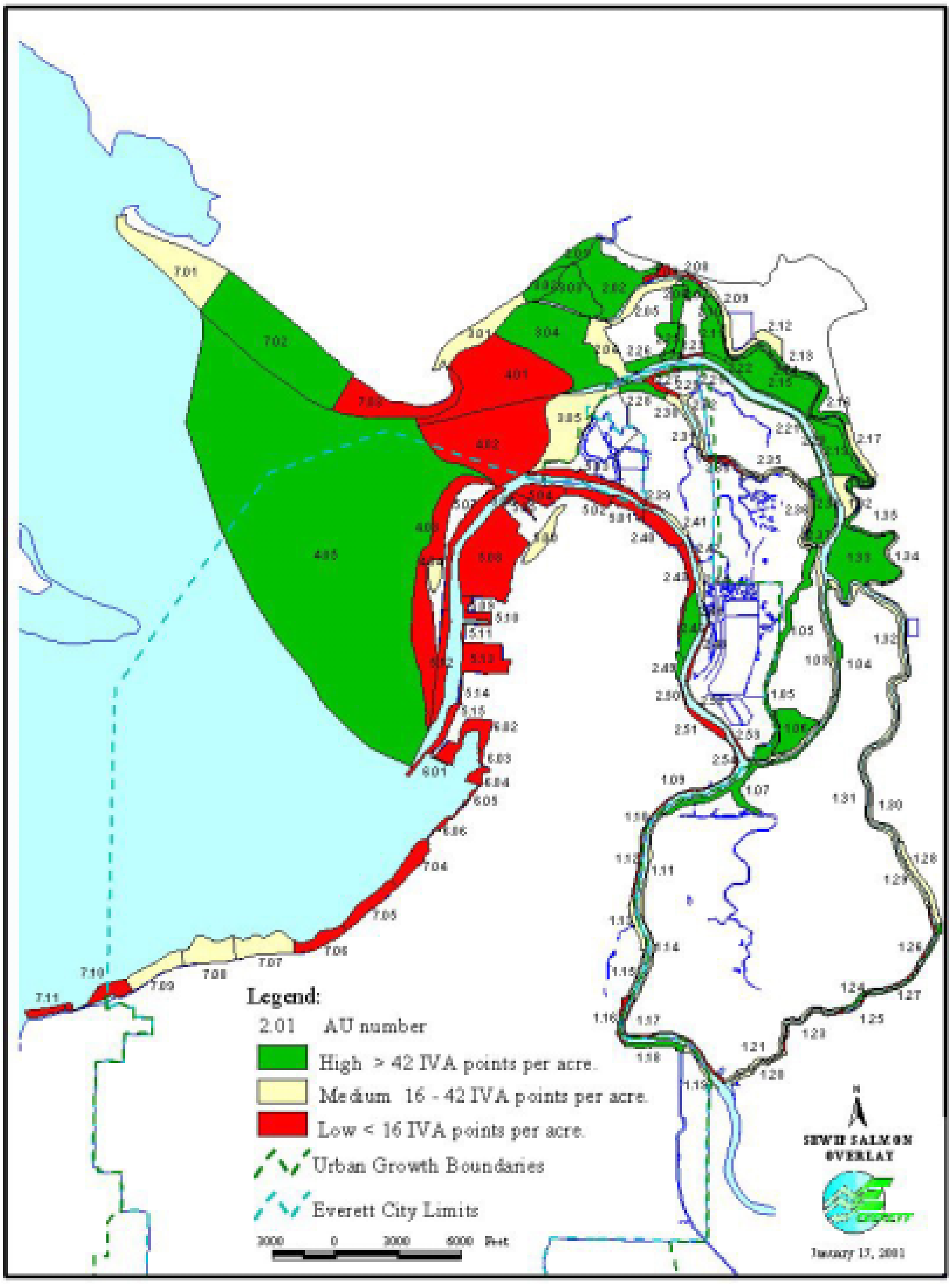

Figure 4. Habitat quality score ranking by AU.

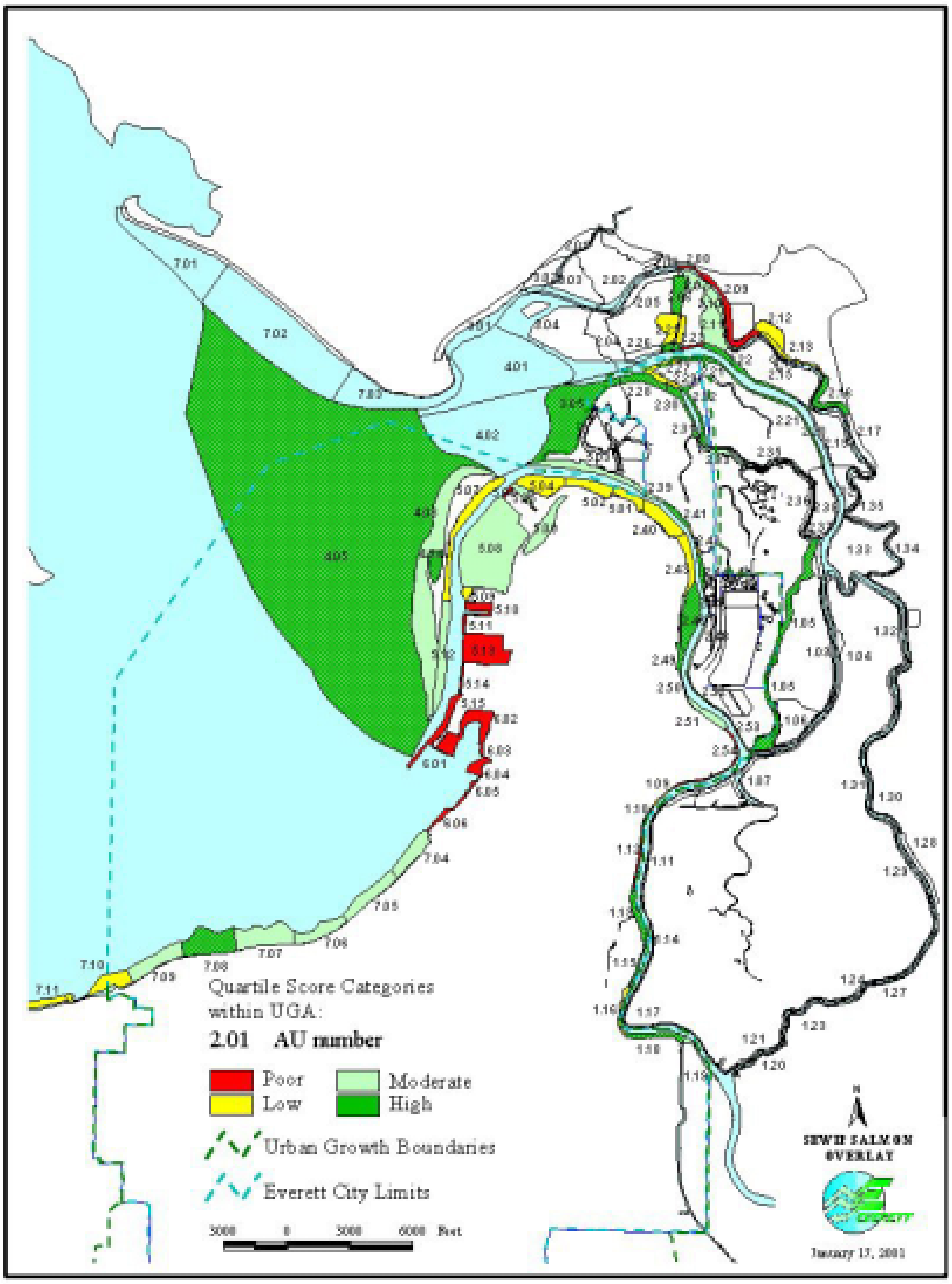

Figure 5. Habitat quality categories (IVA-score quartiles) within Everett and Marysville UGAs.

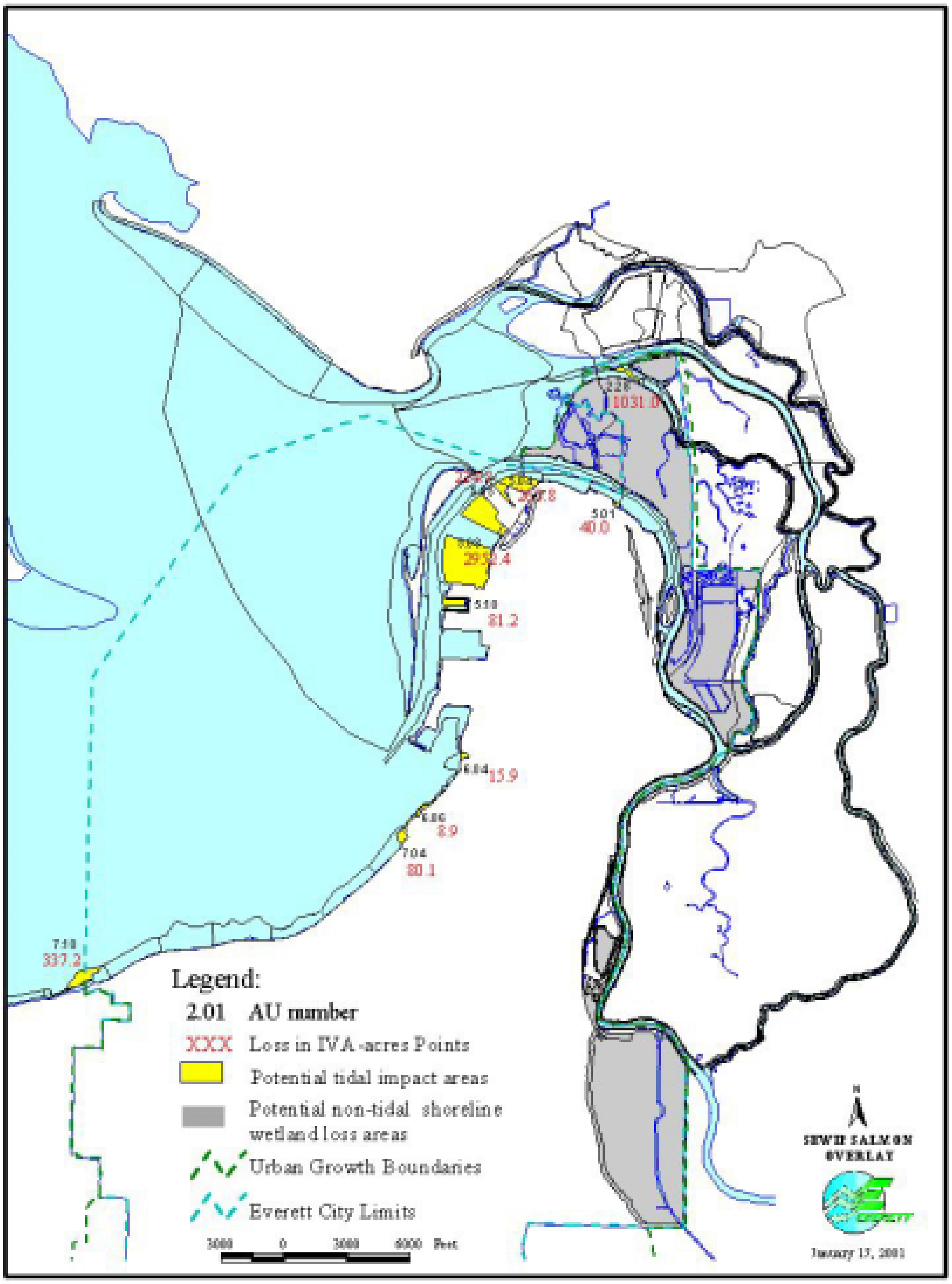

Figure 6. Potential development impacts to tidal and isolated wetland areas under the HDS.

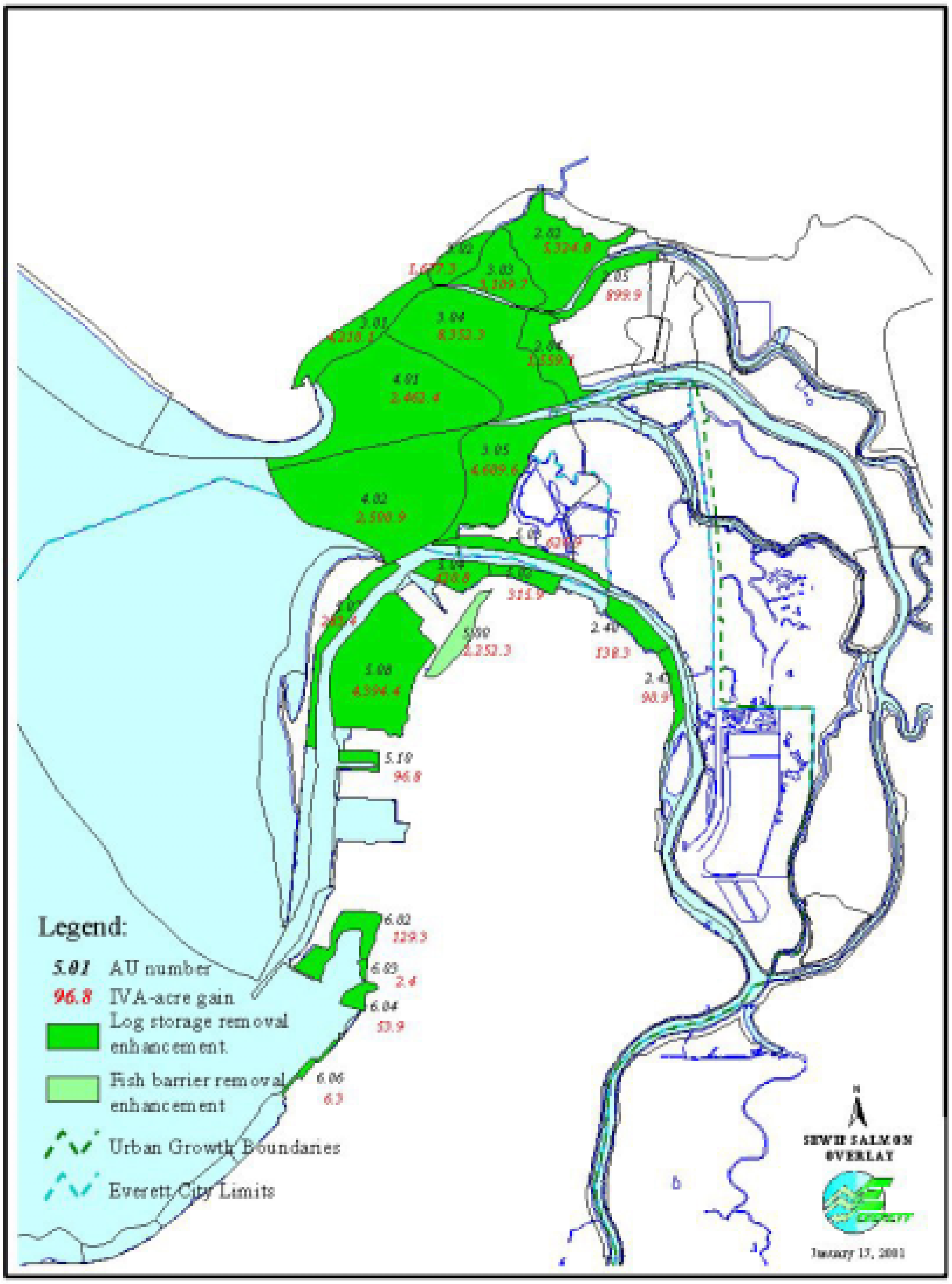

Figure 7. Potential stressor removal (log rafting and fish access) opportunities as associated with IVA-acre enhancement.

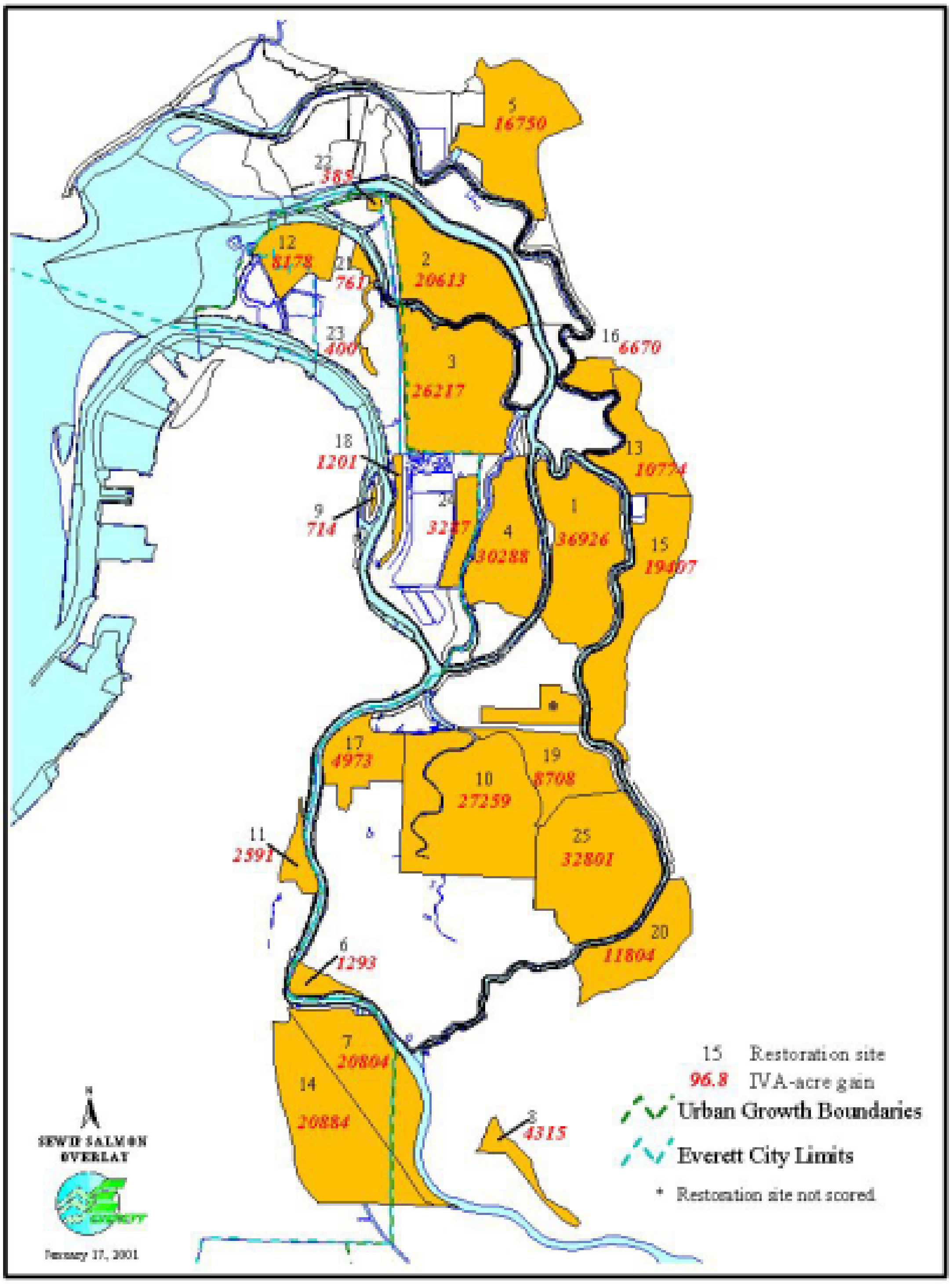

Figure 8. Potential tidal restoration sites.